DIMENSIONS NBS

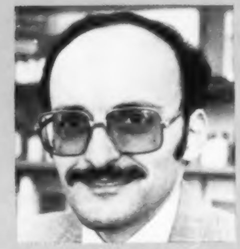
The magazine of the National Bureau of Standards U.S. Department of Commerce

January/February 1981

INDIVIDUAL MONITORS OF POLLUTION. See page 8.

COMMENT

SPOTLIGHTING STANDARD REFERENCE MATERIALS



January 1981 marks the 75th anniversary of the certification of the first reference materials by the National Bureau of Standards. The first four Standard Reference Materials (SRM's) issued in 1906 were a series of cast irons prepared at the request of and in cooperation with the American Foundrymen's Association for use in establishing the accuracy of chemical analytical methods for determining the composition of grey cast irons. It is of interest to note that one of the original reference materials (SRM 4M) has been reissued 13 times and is still used extensively today. This example illustrates an important requirement of reference materials; namely, to provide a continuous supply of essential materials over long periods of time.

During the past 75 years, NBS has developed more than 1700 additional SRM's—nearly 1000 of which are currently available. The worldwide demand for SRM's is growing rapidly. NBS now distributes over 40 000 units each year to approximately 10 000 users throughout the world. In the coming decade, the entire community of producers and users of certified reference materials will face a major challenge—to meet the increased demand for new and reissued SRM's.

The NBS through its Standard Reference Materials program has been a leader within the standards community for 75 years, but it has never worked alone. U.S. industrial laboratories and associations, scientific societies, and private standards-making bodies help guide and support many SRM activities. For example, over 250 different companies within the metals industry participate, through the American Society for Testing and Materials (ASTM), by providing funds, personnel, materials, or services. Many individual industrial laboratories cooperate directly with the Office of Standard Reference Materials (OSRM) to develop and certify SRM's.

The SRM partnership has been expanding in the last 20 years. Since the 1960's, organizations interested in clinical and environmental measurements have helped initiate and support programs in these areas. Finally, other nations have begun to respond to growing needs for standards in support of international goals, such as trade and world health. This recognition, in turn, has spurred global demand for and cooperation in reference materials activities. By law and tradition, NBS is a partner in meeting international as well as national needs.

Based on surveys carried out by OSRM, we estimate that 300 new SRM types will be required to satisfy domestic needs alone over the next five years. International demand for new reference materials will number in the thousands by the end of the decade; thus NBS will meet directly only a fraction of the total requirements. One of the OSRM priorities is effective cooperation with our domestic and international partners so that reference materials will be available on a timely basis for all essential applications.

On the global level, we feel that there are two requisites to success through cooperation: better information transfer and better technology transfer. Organizations such as the International Organization for Standardization and the International Union of Pure and Applied Chemistry must continue to collect information on the availability of SRM's, disseminate this information widely, and develop general guidelines and recommendations in such areas as terminology, certification criteria, and contents of reference material certificates. In the area of technology transfer, greater technical cooperation must develop among various reference materials producers throughout the world to expedite production and certification. To help satisfy pending domestic needs, the OSRM is exploring the possibility of expanding cooperative efforts with ASTM and other organizations.

As already stressed, cooperation is the key to success in the SRM program for the 1980's. If you are a member of the measurement community, you may be interested to know that the first of a DIMENSIONS series of quarterly reports on SRM status is introduced in this issue. You can help to make the SRM program work for you and others by informing us of your particular needs.

George A. Uriano

George A. Uriano, Chief
Office of Standard Reference Materials
National Bureau of Standards
B311 Chemistry Building
Washington, DC 20234
301/921-3479

DIMENSIONS NBS

The magazine of the
National Bureau of Standards
U.S. Department of Commerce
Volume 65/Number 1

January/February 1981

Contents

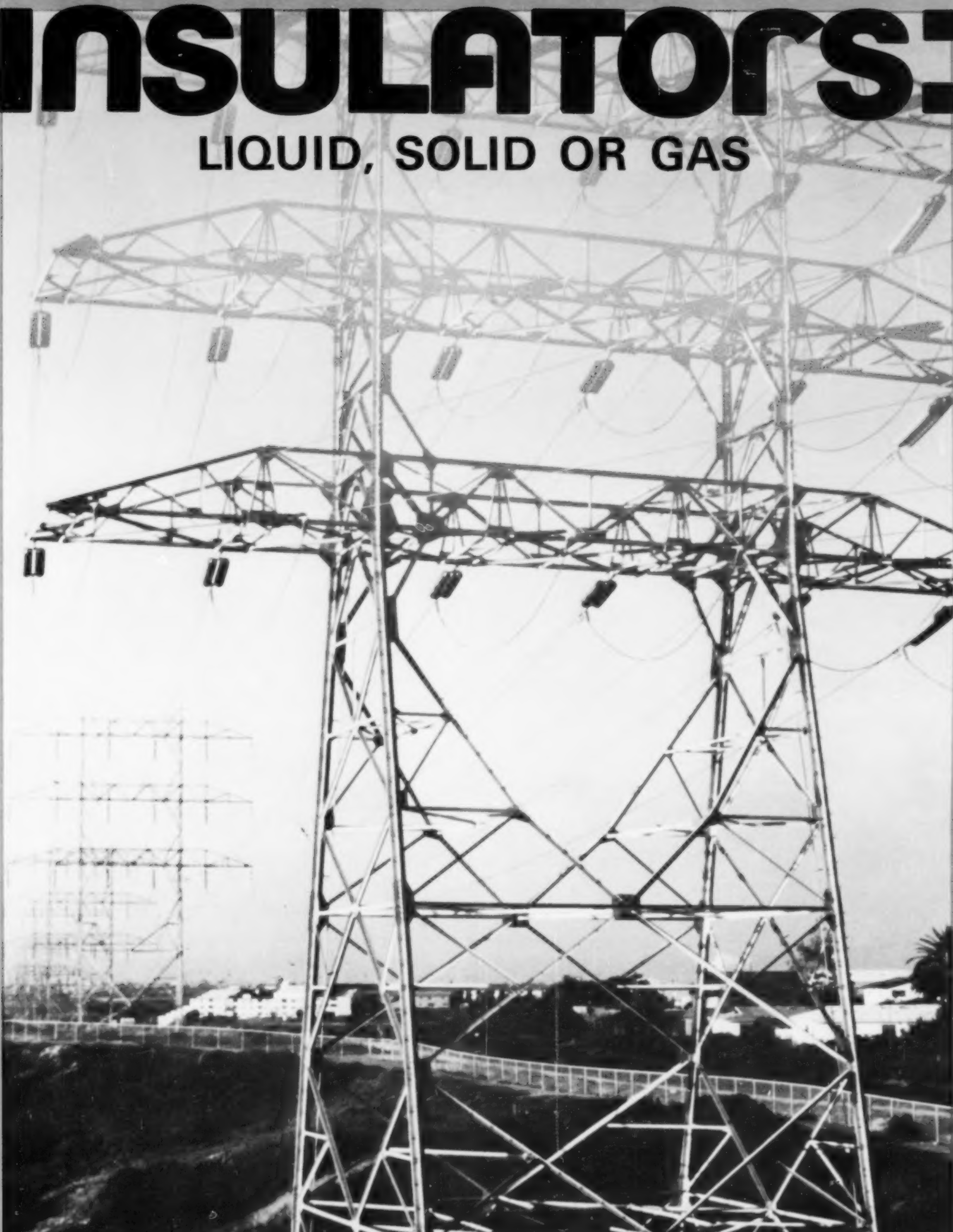
ARTICLES

INTERFACE

UPDATE

INSULATORS:

LIQUID, SOLID OR GAS



SHIELDING THE ELECTRICAL DISTRIBUTION SYSTEM

by Emily B. Rudin

AS the eighties unfold, the term "energy conservation" is becoming almost a national slogan in America. Government and industry are making massive efforts to find new alternatives to petroleum-based fuels. In many cases the energy provided by those alternatives—coal, the sun, nuclear energy, fusion—will be transformed into electricity, largely at centralized generating stations, and therefore the efficient transmission and distribution of electrical power will be even more vital to the well-being of our society than it is today. In fact, we are likely to depend so much on electricity that, even with the adoption of practical energy conservation measures, the demand for it may grow by 50 percent by the end of the decade.

To meet this increasing demand, electrical transmission and distribution systems will need to carry more energy. Tomorrow's efficient systems will have greater "energy density," that is, they will carry more energy at higher voltage than today's cables without requiring significantly more space.

Crucial to the efficient transmission of high-voltage electric power will be insulation capable of reliably withstanding higher voltage stresses than before. With $80 billion worth of electricity being generated annually, if even a small percentage is wasted through poor insulation, the cost is large. At the National Bureau of Standards, researchers are investigating insulation failures and ways to improve the resistance of insulation systems to breakdown, with support from the U.S. Department of Energy, (DOE), the Electric Power Research Institute (EPRI—supported by electric utilities), and industrial manufacturers of high-voltage transmission apparatus. The NBS program, which gained momentum in the mid-1970's with the onset of the energy crisis, is designed to provide these sponsors with test methods, data, interpretive theories, and recommendations concerning future research directions. Liquid, gas, and solid insulators are being studied by the Bureau's Electrosystems Division; new solid polymeric materials are being tested by its Polymer Science and Standards Division.

Insulation Systems: Liquids

Traditionally, insulation during the last half-century has consisted of mineral oil, paper, and pressboard. Together, these components have provided electrical insulation, cooling, and mechanical rigidity for conventional high-voltage electrical apparatus. These components of insulating systems are flammable and are subject to self-heating in use, with consequent deterioration and electrical failure. According to conventional wisdom, these breakdowns occur mostly at the interfaces between the layers. NBS results have demonstrated that this is not necessarily the case (see *Dimensions/NBS*, Nov. 1980, p. 20). The current NBS study aims to provide a scientific basis for understanding the breakdown process, so that industry can predict and control energy losses better and design and construct more reliable high-voltage apparatus. This work builds on the innovative electro-optic techniques for measuring electric field and space charge distributions that had previously been developed by the Electrosystems Division. These Kerr-effect investigations provide improved means for characterizing high-voltage pulses and space-charge dynamics in liquid insulants under 60-Hz (line) voltage stress.

A breakdown, also called a streamer or tree, can race at 4 million centimeters per second in a lightning-like leap from the conductor through the insulating layers. Such speed requires advanced photographic techniques to record the event. In the laboratory test chamber, sophisticated equipment (including timing instruments, digital oscilloscopes, and a computer control) enables researchers to synchronize the breakdown event to within 10 nanoseconds. (One nanosecond is one-billionth of a second; the streamer travels 0.004 cm, a little more that the thickness of this page, in a nanosecond.)

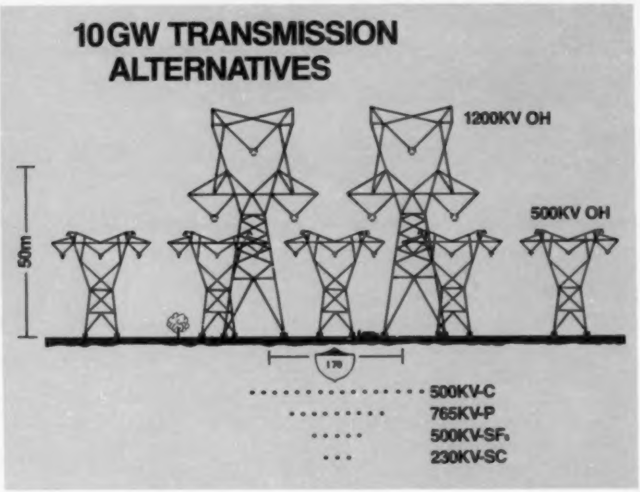
"The very short time interval, combined with an electric field strength of over a million volts per centimeter during a breakdown, makes this measurement problem a technically challenging one," comments project leader Robert E. Hebner, Jr.

Insulation Systems: Gases

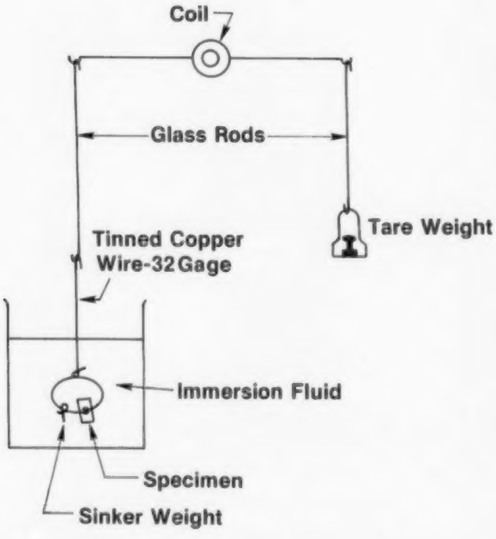
In contrast to the well-understood dynamics and more than 50-year history of liquid insulation systems, compressed-gas insulated systems present more unknowns to researchers; these systems have been in use only about 15 years. "We're in maturity with oil and paper," Hebner explains. "With gases, we're in adolescence. We don't have the years of experience or level of sophistication with gases that we do with oil and paper, nor the measurement techniques to determine insulation effectiveness."

Compressed-gas insulation has low energy losses compared to those encountered with oil and paper,

Rudin is a writer and public information specialist in the NBS Public Information Division.



Comparison of the estimated right-of-way required for two overhead (OH) and four underground alternatives for transmitting 10 GW of electric energy. The underground approaches include cables insulated with oil and paper (C), polyethylene (P), and compressed gas (SF_6) as well as a cable system operating at superconducting temperatures (SC), approximately 4 K. Although underground systems are considerably more expensive to construct and maintain, they require less right-of-way and have less visual impact.



A schematic design of the sensitive mass balance used in void-filling measurements.

and it is particularly suitable for high-voltage cables because it permits much higher amounts of energy to be transmitted for a given cross-section. Oil is generally used to insulate transformers or underground cables in urban areas. Compressed gases—such as sulfur hexafluoride—are being developed for use in high-voltage underground lines and have been used in some modern high-voltage switching apparatus. In many regions, the existing rights-of-way for overhead lines, which are insulated by the surrounding air, are already full. To thread additional high-voltage cables through these areas would drastically decrease the safety and reliability of the systems. Compressed-gas cables provide a solution.

If high-voltage lines insulated with compressed gases solve one problem, other questions, ironically, begin to surface. Eventually, the materials are bound to deteriorate. Ten years from now, what will electrical engineers see when they open the line? Discharges in the line may have resulted in the formation of toxic and corrosive compounds—such as the gaseous oxyfluorides of sulfur—that threaten the integrity of the line. An additional concern is that over long periods, the accumulation of toxic gases may reach concentrations that could affect safety if a leak suddenly occurred. Bureau researchers are developing techniques and models for making and interpreting short-term measurements in order to predict long-term changes in compressed-gas insulation systems.

One possible key to forecasting changes in an underground cable is to measure electrically the pattern of low-level discharges that develop inside the gas when a high voltage is applied to the inner conductor. These electrical discharges, seen as little sparks, produce changes in the chemical composition of the gas. The partial-discharge measurement system used to characterize these discharges was developed in the Electrosystems Division primarily to study aging in superconducting cables. This fast, flexible system is capable of calculating important experimental parameters, such as discharge energy as a function of time, and therefore is well suited to measurements on compressed-gas systems. NBS researchers have discovered that small chemical changes in the gas apparently correspond to large changes in electrical behavior. Establishing a correlation between the two, they think, is crucial to understanding how insulating gases break down and how the breakdown process works as a whole.

To arrive at this correlation, the scientists must investigate the process between the initial electrical discharges and the final chemical changes. When sparks occur, how does the molecular composition of the gas change, both instantaneously and cumulatively? "The electrical measurements give us one piece of the puzzle," Hebner explains, "and the chemical measurements give us another. But we need to find the missing pieces: the dynamics of getting from one end of the process to the other."

Filling in the puzzle includes simultaneous analysis of a discharge and its products by several techniques. When the discharge in the test cell occurs, those electrical parameters not under direct control are characterized, while optical techniques are used to measure both absorption and emission of light. In addition, gas samples from the cell are analyzed by a combination of a gas chromatograph and a mass spectrometer, which produces a spectrum showing the concentration of chemicals in the gas after electrical degradation.

Ultimately, when scientists understand the gas-discharge dynamics, industry will have the measurement techniques to assess the long-term reliability and safety of gas insulation in a high-voltage system and the information needed to design a system that minimizes the effects of discharges.

Insulation Systems: Polymers

NBS researchers are concerned with two broad areas of application for solid insulating systems used underground: cables used for high-voltage power transmission lines of both normal (extruded insulation, tape insulation) and superconducting (tape insulation) types, and cables used for distribution systems (extruded insulation). Superconducting lines for high-voltage transmission, if practical, would offer low losses and require even less space than high-voltage compressed-gas lines for equivalent energy transmission capability. The materials characterization efforts of the Bureau's Polymer Science and Standards Division relate to extruded polymer insulation and to both types of tape insulation; this work is described below under the heading "Materials Studies for Underground Cables."

Electrical Performance of Underground Cables

The measurement studies on solid insulation carried out by the Bureau's Electrosystems Division are designed to detect and characterize failures and ultimately to provide information that will permit the construction of cables that minimize the number of failures over the design life. Solid insulation is typically made from a versatile polymer like polyethylene. Its advantages include resistance to weathering, low conductivity, low cost relative to other dielectrics, and (as finished cable) ease of installation. Although pilot installations of 100-kilovolt (100-kV) polyethylene transmission lines are in place, and although there are a number of operational installations of 69-kV polyethylene line, the most common use of extruded insulation in electrical power systems is in low-voltage (less than 15 kV) distribution systems such as the one that feeds your home.

To construct a solid cable, the manufacturer extrudes a thick layer of polyethylene or other polymer in the space between inner conducting cable and outer protective sheath. Although this insulation is generally reliable, it can still break down and leak energy. In fact, the lifespan is turning out to be shorter than anticipated. The problem is compounded by the fact that the cable is underground. Pulling up and replacing a defective cable is very costly for the utility and the consumer and, because power must be out during such repairs, it is usually a major inconvenience as well.

"Ideally," Hebner says, "we would like to be able to send a radiofrequency signal down a cable and have it send up a flag that warns, 'I will fail a week from Thursday if you don't fix me.' Then the utility could schedule an outage at a convenient time of low demand, reroute the power to minimize the size of the area that would be without electricity, and replace the cable. That," he concludes, "would be the cheapest way to replace a cable with mini-

mum disturbance of the service."

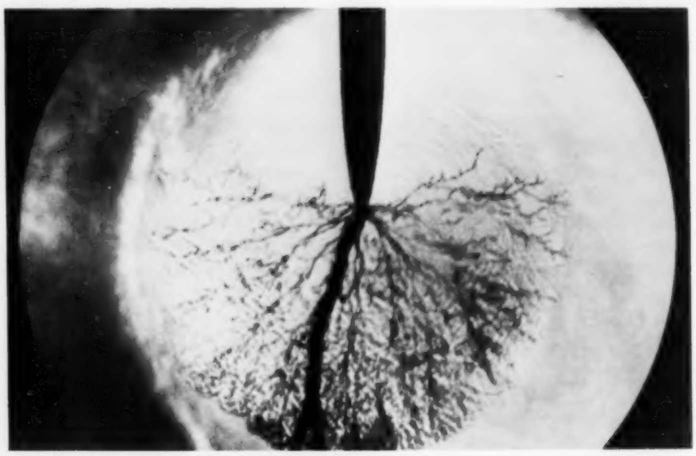
Working toward that ideal in the laboratory, the project's staff is examining radiofrequency (RF) signals emitted from transmission cables with solid insulation. They believe that changes in the way a cable sends out self-generated RF signals and in the way RF signals propagate along the cable provide clues that a failure is imminent. RF signals having frequencies as high as 500 MHz are launched down a test cable, and reflections from the far end, and from any discontinuities along the length, are received and recorded. In a technique known as time-domain reflectometry, the distances to discontinuities, which represent potential failure sites, and other characteristics of the applied and emitted signals are determined. This work is being carried out with the assistance of staff members from the Bureau's Electromagnetic Technology Division, who are applying analysis expertise developed for studies on communications cables to the power regime. The final yield is a set of data that provides detailed information on the state of the solid insulator. Based on an accumulation of such results, the researchers hope eventually to have the measurement base and data analysis techniques for predicting and hence minimizing the effects of breakdowns in solid insulation.

Materials Studies for Underground Cables

Knowledge gained from experience with the oil-paper insulation system is being applied by scientists in the Polymer Science and Standards Division in their attempts to replace the paper component with a material of lower dielectric loss. The materials characterization is applied to tape insulation both for cryogenic superconducting cables and for ambient-temperature transmission cables.

Very special solid materials are needed to insulate superconducting cables. A superconducting cable is what its name implies: a high-voltage cable in which the electrical flow meets virtually no resistance from the conducting metal. To reach the superconducting state, the metal is cooled with liquid helium to temperatures near absolute zero (6 K to 9 K). The low-temperature environment places heavy demands

Anthony Bur, NBS polymer scientist, operating test apparatus. The horizontal glass cylinder at the top is a sensitive mass balance. The specimen is suspended in oil in the vertical glass cylinder.



Photograph of an electrical breakdown in transformer oil, showing the breakdown between the anode (needle) and the cathode (plane). The hemispherical structure is the disturbance in the liquid preceding breakdown.

on the electrical and mechanical properties of the insulation system.

For the superconducting cable being developed at DOE's Brookhaven National Laboratory (BNL) in Upton, NY, the insulation consists of layer upon layer of polymer tape wound tightly around the inner conductor. When a cable is cooled, the polymer tape is subject to tremendous tension, leading to possible fracture. Wrapping the cable around a giant spool during transport or storage and unwrapping it for installation underground also create stresses that the tape must survive.

The measurement of material properties to select polymer tapes suitable for this application is a major focus of NBS research. Headed by Martin Broadhurst and funded by DOE, one aspect of the project is designed to measure very accurately low levels of energy loss in polymer tapes used for wrapping superconductors. An NBS-developed instrument, consisting of a cell for measuring electrical properties and a capacitance bridge, enables the researchers to gage these energy losses at both low and high temperatures. The device is carefully controlled and the instrument accurately measures a dielectric loss tangent of one part per million. Polymers with a dielectric loss of 20 parts per million or less are needed for use in superconducting cables—otherwise, the energy dissipated in these insulators would outweigh the energy normally lost from the conductor during operation.

NBS also uses x-rays to characterize the molecular orientation in these tapes and mechanical tests to measure their compressibility. Such data are crucial factors in predicting the flexibility and strength of the final cable.

During the past year, the search for suitable polymer tapes has produced a possible winner—a material made up of two polypropylene sheets bonded together with polyurethane cement. "Initial results indicated how the material had to be modified," Broadhurst says. "Now it looks like the tape that has evolved has a good chance of success for cables cooled with liquid helium." These tapes seem to meet several criteria: they are compressible enough to allow the cables to be wrapped on spools and stacked during storage or transit; they can withstand tension when wound tightly around the inner conductor; and the amount of energy lost from the insulation will not be prohibitive.

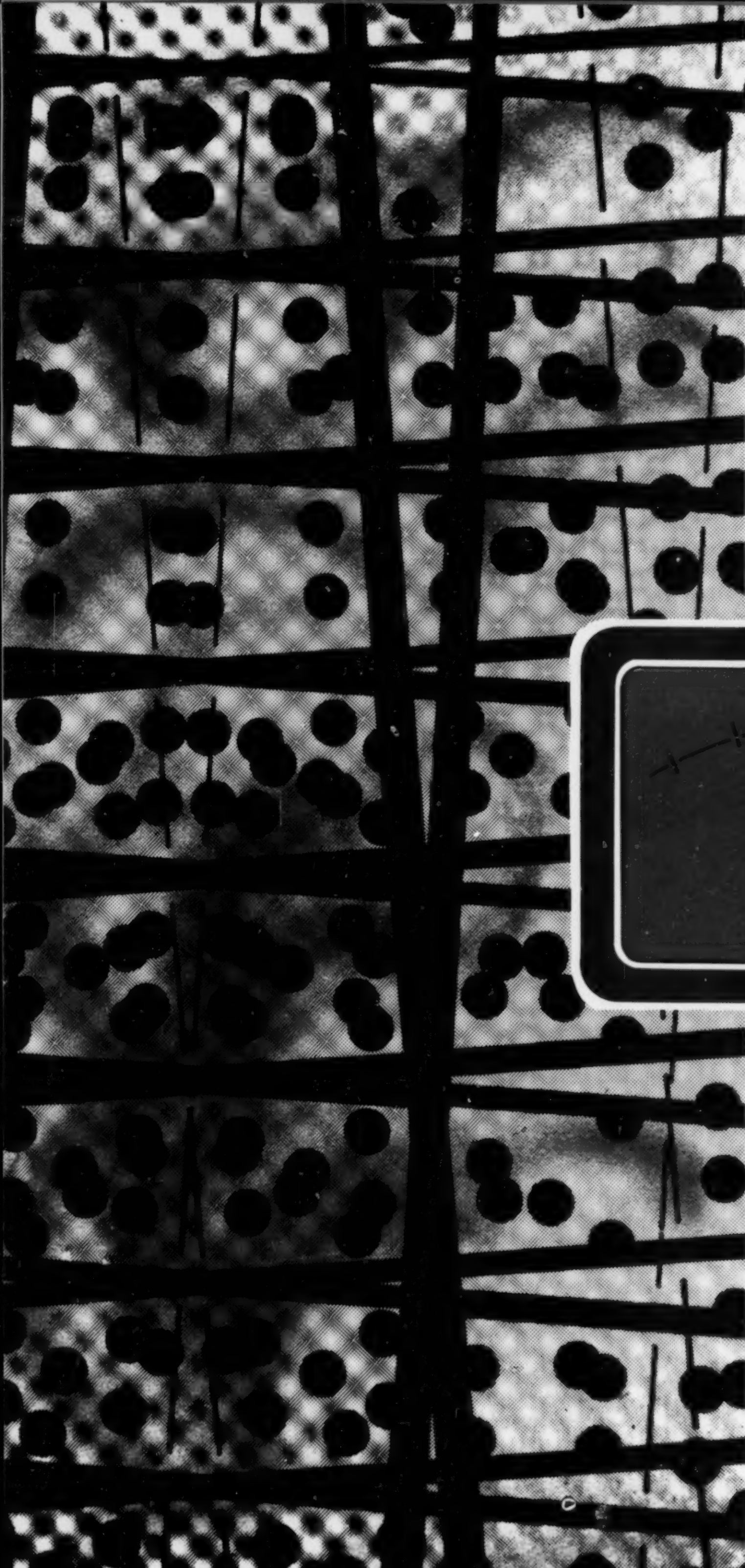
In two other efforts to improve insulation for a new generation of ambient temperature transmission cables, work is underway to screen solid polymers (in cooperation with Brookhaven National Laboratories) and develop screening tests for porous polymers (in cooperation with EPRI). Traditionally, ambient-temperature transmission cables have been made by wrapping the inner conductors with multiple layers of paper tape and soaking the completed cable in oil in order to fill all voids and gaps between the tapes which might provide sites for breakdown to begin. Although the paper readily soaks up the oil, paper-insulated cables lose increasingly large amounts of energy and need forced cooling at higher voltages. A replacement material for paper, therefore, must be able to withstand the stresses of heating and cooling, have low energy losses, and absorb oil completely with no voids left unfilled.

Two types of polymer insulating tapes have been considered as substitutes for paper tapes—a solid polymer tape and a porous polymer tape. So far, solid polymer tapes have not provided a suitable substitute for paper and the research for such a substitute is the subject of the cooperative NBS-BNL effort. Porous polymer tapes are being considered in order to simulate paper closely enough to be usable with present cablemaking technology but still avoid the poor electrical properties of paper insulated cables.

Researchers are developing methods to test synthetic porous-polymer substitutes for paper. "If a company comes up with a new porous polymer tape," Broadhurst says, "how can a utility or cablemaker know whether it will be good for insulating cables? The NBS program aims to provide tests and standards that people in industry can use to find out." Since the application of porous polymers to room-temperature cables is new, these test methods and standards are constantly being refined and redefined.

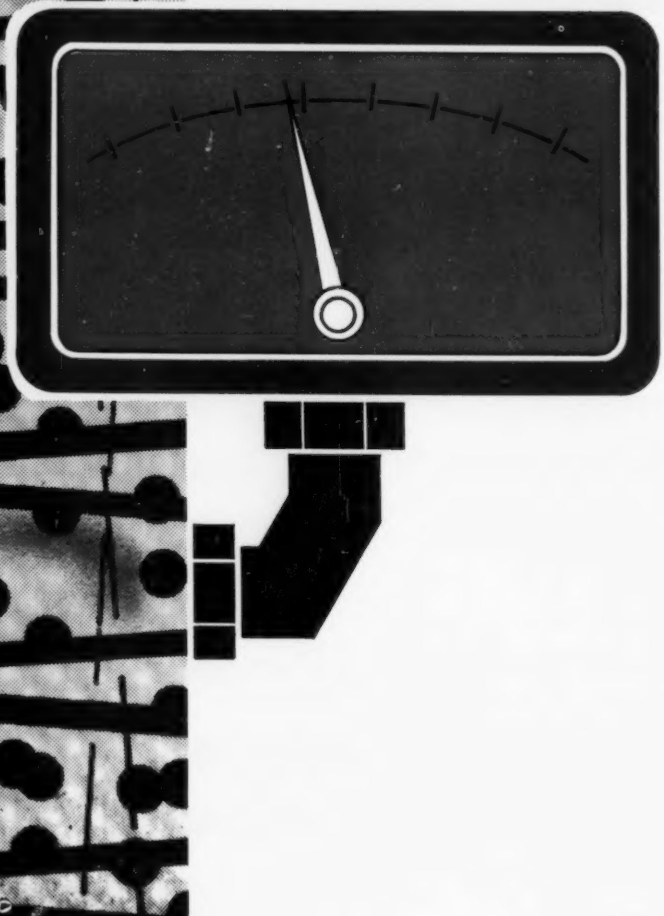
A typical porous polymer tape might look solid, but it is actually 50 percent void volume. It is not a good insulator unless the void volume can be completely filled with oil, in which case the tape turns clear. NBS has devised a test to measure the "fillability" of various polymer samples, by monitoring changes in each tape's weight as it absorbs oil. Good candidates quickly become saturated and heavy. Poor ones absorb oil slowly or even dissolve.

As the NBS researchers—in collaboration with Government and industry scientists—develop the tests to characterize electrical insulation materials, it will be possible to design more effective transmission cables to carry more power more effectively. And that is a giant step toward meeting America's demand for safe, reliable, and plentiful energy in years to come. □



COVER STORY

A SAMPLE A DAY...



Personal Monitors of Pollutants

by Gail Porter

SAD but true, the vast majority of Americans spend most of their time indoors. About 90 percent of their time, in fact. Which is to say that most people spend most of their time breathing "indoor air."

While you may not find that too surprising, it is a fact that is becoming increasingly important to researchers who study the effects of air quality on health.

Since 1963, when the Clean Air Act was passed by Congress, much attention has been focused on improving the quality of ambient air. In practice, this has meant monitoring and regulating the pollutant levels of outdoor air exclusively.

The unspoken assumption of this approach has been that if the outdoor air meets certain quality standards, then indoor air will follow suit. However, recent studies of indoor pollutant levels are proving this assumption to be false for many pollutants.

Take the example outlined in a recent article on indoor air pollution appearing in *Environmental Science and Technology* magazine. The author of the article describes the makeshift test devised by James Repace, an employee of the Environmental Protection Agency (EPA) who carried a portable air sampler around through a full day of activities. He found that his highest exposure to respirable particulates (particles that can penetrate the lungs) occurred while cooking dinner in a well-ventilated kitchen with a gas stove. The second highest exposure occurred while sitting in the smoking section of a cafeteria. Exposure levels recorded while driving behind a smoky diesel truck came in a moderately poor third.

During the past few years, the results from studies like this one have prompted EPA to try profiling pollutant levels indoors as well as out. Initially, two approaches were followed. The agency performed fixed station air sampling at a variety of different indoor locations and developed mathematical models to predict the pollutant exposure of individuals throughout a full day of complex activities.

Neither of these approaches, however, is as definitive as taking direct measurements of an individual's exposure to specific pollutants.

Individual Pollutant Exposure

"One of the basic problems with current epidemiological studies of pollutant exposures," explains Lance Wallace, an EPA environmental scientist, "is that researchers don't have solid numbers for the received dose. They have detailed records of hospital cases, but they really don't have a good idea of the pollutant levels a particular patient has been exposed to."

For short-term effects, such as an increase in reported cases of asthma or angina attacks due to elevated levels of particular pollutants, data on individual exposure could be very valuable in verifying the levels at which pollutants cause health problems.

Secondly, a measure of individual pollutant exposure would, according to Wallace, be very helpful in the regulatory process. For example, if only one group has problems upon exposure to a certain pollutant, then EPA should be able to fine tune its regulatory requirements to protect that one group specifically.

Few people dispute the idea that data on individual pollutant exposure levels would be nice to have. Fewer still have good ideas on how such information could be reliably collected. The problem is that there are not many devices available that can be easily worn or carried by subjects participating in experiments.

Not many people, for example, would be willing to carry a lunch pail sized instrument with a hose

Barry Cadoff sets up a test run to judge the reliability of a new NBS-developed device for passive sampling of nitrogen dioxide (NO_2).

Porter is a writer and public information specialist in the NBS Public Information Division.

attached to their collar from home to work, from the grocery store to the bowling alley—morning, noon, and night. For the measurement of particulates, which are of special interest to researchers studying indoor pollution, this type of instrument has been the only one available for making measurements of individual exposure.

Within the past few years researchers have had some success in designing small, quiet monitors that are inconspicuous enough to be worn or carried easily. Many of these devices, however, were created for workplace monitoring and are designed to measure pollutant concentrations 10 to 1000 times higher than the concentrations usually found in ambient air.

EPA has asked the National Bureau of Standards to help evaluate the accuracy of the various types of personal pollutant monitors currently available, to suggest design changes that might improve the sensitivity and sampling reliability characteristics of these devices, and to develop new monitors where required.

At this point in their work, NBS researchers have studied two different kinds of sampling devices (passive and active) designed to collect two different types of pollutants—NO_2 (nitrogen dioxide) and particulates. Active devices are those that incorporate a pump to collect the sample. Passive devices rely instead on the principles of gas diffusion.

Active Particulate Samplers

"Normally when you do air sampling," says Jimmie Hodgeson, project leader for the NBS study, "you have some sort of collection medium (such as a filter), a flow measurement device, and an air pump." The air pump pulls a sample into the device, the flow meter determines the rate at which the air is entering so that the sample volume can be calculated, and the collection medium selectively extracts the appropriately sized particles or compounds of interest.

This kind of active sampling device is the type needed for measuring particulate concentrations. Recently environmental and health researchers have reported that cigarette smoking can be a major source of particulate exposure for people who spend most of their time indoors. One study, for example, showed that residents of Watertown, Massachusetts, were exposed to linearly increasing levels of particulates depending on the number of smokers living in an individual home.

NBS researchers are trying to build a scaled down model of the lunch box sized samplers used in the Watertown study (and others like it) that will be smaller, less conspicuous, yet accurate. They have already evaluated a number of small air pumps and batteries and chosen a system capable of sampling 6 liters of air per minute for about 60 hours.

The pump system, which weighs about 1 kilogram, was insulated to keep noise to a minimum and incorporated into a plain box about half the size of a desk dictionary. The researchers also selected and built into the box, filters of different pore size to allow sampling of two size ranges of particulates—2 to 15 micrometers and below 3 micrometers.

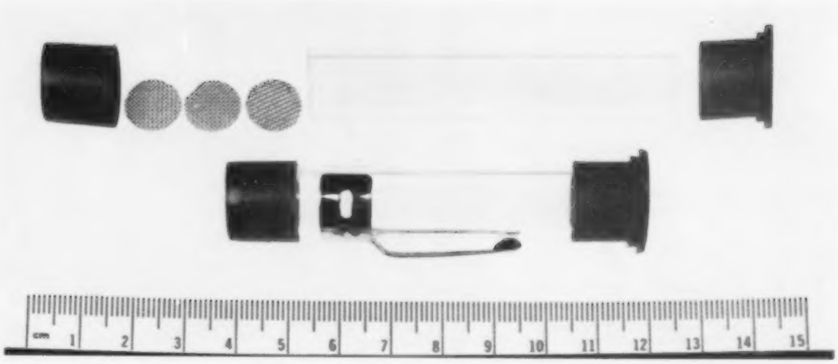
The accuracy with which a device can collect particulates representative of the surrounding air is dependent on a number of complex variables. In particular, the "effects of winds are quite pronounced," says NBS research chemist David Bright. So, Bright and colleague Robert Fletcher enlisted the help of the NBS Fluid Engineering Division to design, construct, and instrument a small specialized wind tunnel.

Unlike most wind tunnels, states NBS engineer Pat Purtell, this one had to be absolutely air tight to prevent particulates or toxic compounds from leaking into the lab from the tunnel and to keep the "dirty" lab air from contaminating the well-characterized air samples in the tunnel.

In addition, the air flow through the tunnel had to be uniform with very little air mixing or turbulence. The air flow was tested by hot-film anemometry and by injecting a special fluorescent aerosol at one end of the tunnel and observing the distribution of particles on a grid at the other end.

With the construction and characterization of the tunnel completed, these researchers are now experimenting with both liquid and solid aerosols to test the reliability of their particulate sampler. Known concentrations of the aerosols are introduced into the tunnel, where air speeds can be varied from 1 to 9 kilometers per hour. The known concentration is then checked against the concentration calculated from the weight of particulates actually collected on the filters of the sampler.

"Our goal is to obtain a sample dust deposit in as even a layer as possible," says Bright. An even distribution is necessary in order to use a technique called x-ray fluorescence to determine the sample's chemical composition. This technique is a relatively quick method requiring a minimum amount of sample handling and is presently used to screen the chemical composition of particulates from large fixed station air samplers used for outdoor measurements.



Palmes Sampler

West Sampler

Right. View of commercial filter holder for NBS passive NO_2 sampler. Filter is secured on top and a stainless steel screen, coated with triethanolamine, is inserted in the holder. The opening at the bottom (not shown) is capped.

NBS researchers (from left to right, David Bright, Pat Purtell, and Bob Fletcher) analyze the flow characteristics of a small specialized wind tunnel, built for use in testing personal particulate samplers.

Passive NO_2 Samplers

NBS researchers are also studying two passive samplers designed to measure an individual's exposure to nitrogen dioxide. Since passive samplers do not use a pump and battery system, these devices can be made very small and lightweight.

One of these devices was created by Edward Palmes of the New York University Medical School. It consists of a small hollow tube only 7 cm long, which can be clipped to a collar or shirt pocket. The diameter of the tube is designed to be small enough in comparison to its length to set up a stagnant air zone. Turbulent air from the room, or outside air, is slowed to a rest inside one end of the tube, which is left open. Then simple gas diffusion determines the rate of air flow to a set of three collection screens at the other (closed) end of the tube. The screens are coated with triethanolamine, a chemical that reacts quickly with nitrogen dioxide to produce nitrite (NO_2) ions.

To determine the amount of nitrogen dioxide collected by the sampler the analyst pours a tiny amount of a reagent solution into the tube, caps the open end, and shakes the sampler. The reagent produces a red-violet solution when mixed with NO_2 ions, and the intensity of the color tells the analyst how much NO_2 has been collected from the atmosphere.

The second device is the brainchild of Philip West of Louisiana State University. By virtue of its much larger surface area (see photo), this device can collect NO_2 10 times faster than the Palmes sampler. In this device, the diffusion or air flow rate is determined by a silicone membrane. This membrane is also coated with triethanolamine and analyzed with the color-producing reagent.

Combining the strong points of each device, Hodgeson and NBS research chemist Barry Cadoff have built their own version of a passive NO_2 sampler. This device is similar in geometry to the West model with a relatively large surface area, but the collection of NO_2 is based on gas diffusion rather than membrane permeability.

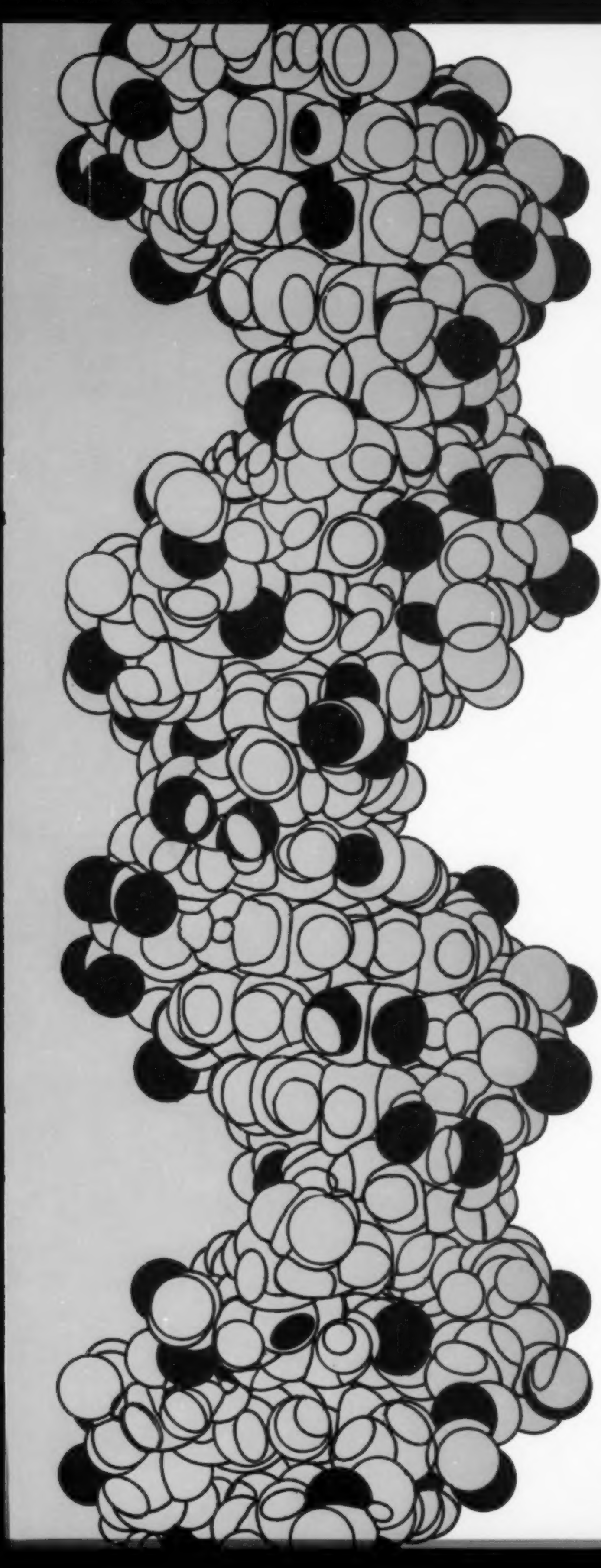
"We're using a commercially available filter with well-defined micrometer-sized pores as the collection medium," says Hodgeson. "These filters have literally millions of holes and each of them acts as a miniature diffusion tube. Because there are so many holes," he explains, "you can get an adequate sample in an hour or two instead of collecting it over 24 to 48 hours."

When tested in a controlled atmosphere of NO_2 in nitrogen with low air flow, the Palmes and NBS devices have performed well. The researchers are now evaluating the performance of each device in the wind tunnel at different air speeds, with the samplers placed in a variety of positions relative to the incoming air.

"Passive badges could well be the wave of the future," comments Wallace. "They have further to go before they will be as sensitive as the active samplers, but they are lighter, cheaper, and easier to use."

For the present, EPA has initiated field studies of individual exposure to air pollution with the samplers now available and will be using the NBS data, in part, to evaluate the usefulness, reliability, and accuracy of these devices.

Those of us who get most of our exposure to the great outdoors while walking to and from parking lots will be anxiously awaiting their results. □

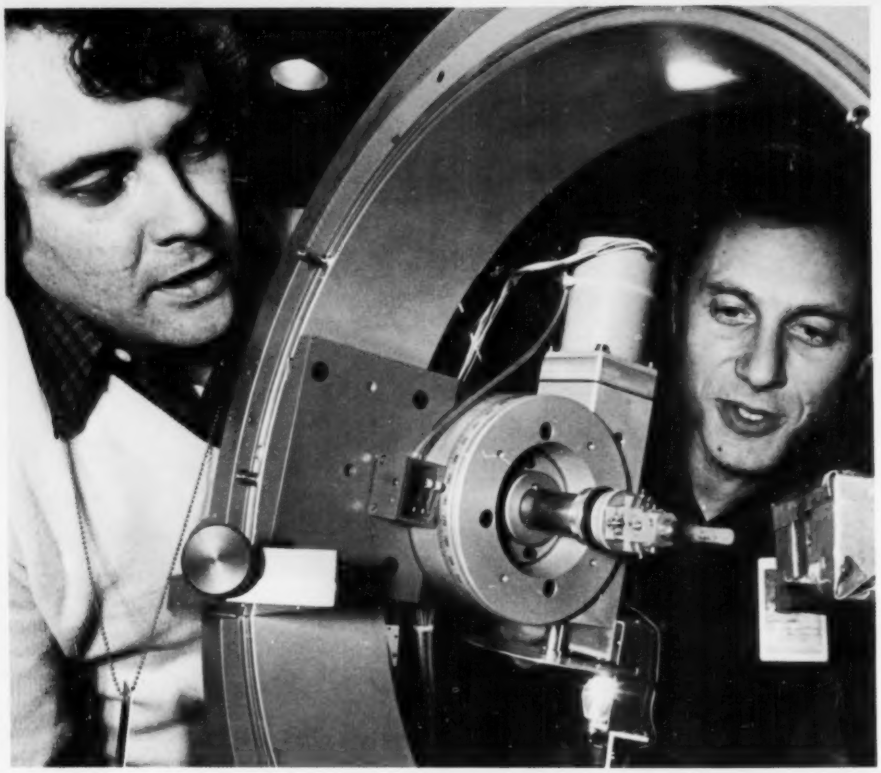


"SEEING" IS BELIEVING

IMAGINE trying to decipher the exact shape and composition of something with more than 10 000 different components that you can neither see nor feel. That is the dilemma faced by Alexander Wlodawer and Lennart Sjolin as they attempt to define the crystal structure of an important protein needed for digestion.

To make their job a little easier, Wlodawer, an NBS physicist in the Reactor Radiation Division, and Sjolin, a guest worker from Sweden for the National Institute for Arthritis, Metabolism, and Digestive Diseases (NIAMDD), have developed a new statistical technique called the "dynamic mask procedure."

The new technique is essentially a method of correctly extracting pertinent data from the midst of considerable background or noise signals. It is expected to result in significant improvement in the analysis of data collected for defining the structure and composition of complex crystals. The technique is also useful for crystallography studies involving x-ray diffraction techniques and in other spectroscopic fields where multidimensional data are collected in the presence of relatively large amounts of random signals.



Lennart Sjolin (left) and Alexander Wlodawer examine a sample of the protein, ribonuclease, as part of their neutron diffraction studies of the protein's crystal structure.

The main advantage of this procedure over other diffraction data processing methods is that the dynamic mask technique does not waste any data. Background signals are not immediately discarded, but instead are used systematically to isolate reflection signals of interest.

Crystallographers, like all atomic and molecular researchers, are handicapped by the lack of any direct way to actually "see" the bonding patterns they study. They rely instead on the use of x-rays or neutrons as "probes" to help them infer information about the shapes and chemical composition of crystals. This kind of information is very important for understanding both the physical and the chemical properties of crystalline materials such as metals, alloys, minerals, ceramics, and certain kinds of organic compounds.

Nowhere is a crystallographer's job more difficult than in the study of macromolecules like proteins. The sheer size of these molecules–with molecular weights in the range between 10 thousand and 10 million—makes detailed study of particular bonding orientations and compositions extremely time-consuming and difficult.

Neutron Diffraction

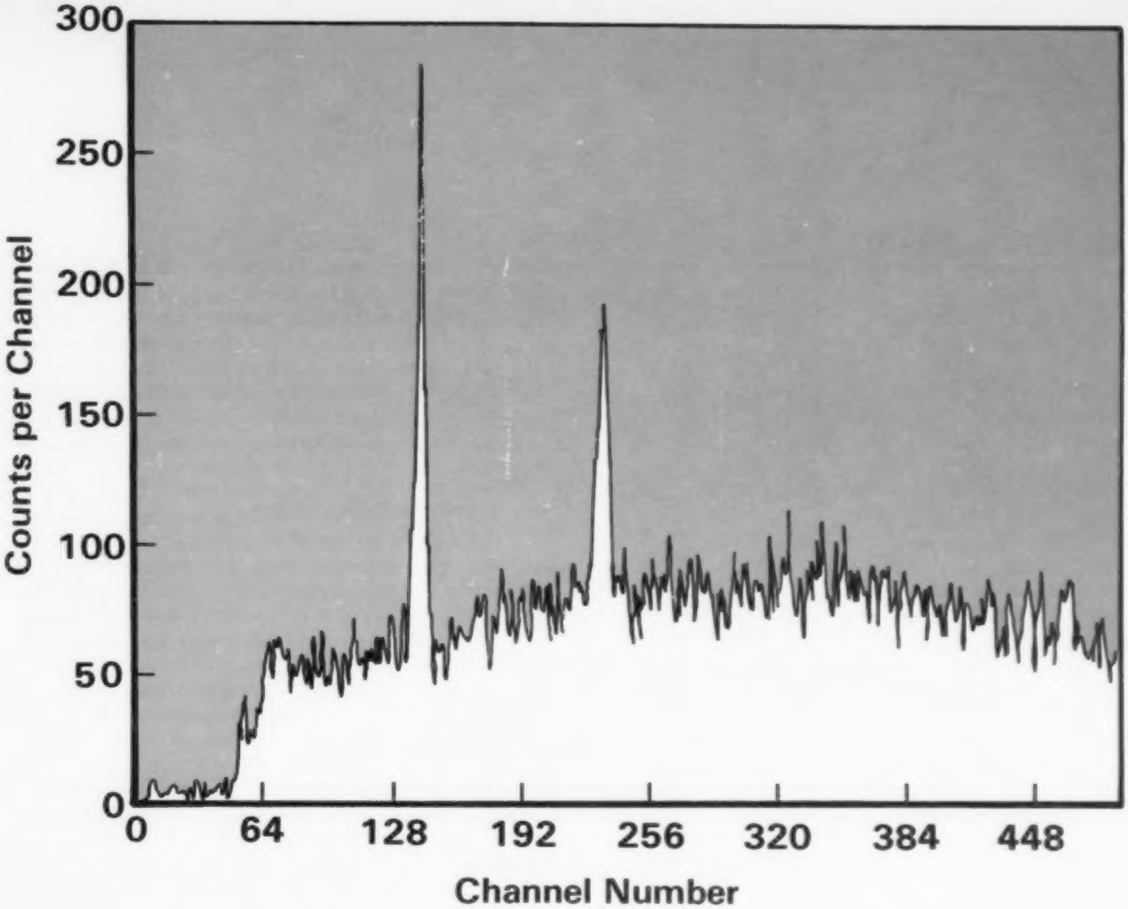
Wlodawer, for example, has been collaborating with NIAMDD researchers for several years to identify the structure of the digestive enzyme ribonuclease. NBS is one of only three laboratories in the world with a facility for neutron diffraction studies of proteins.

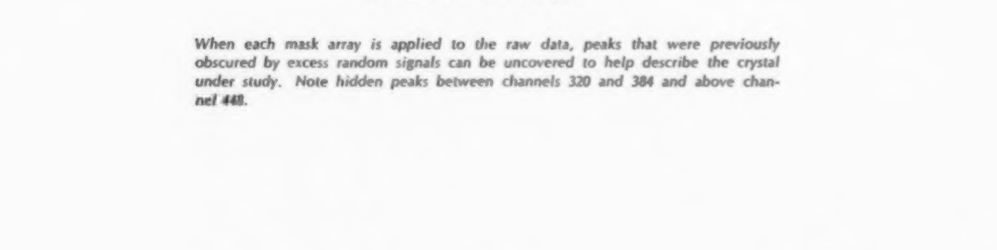
In practice, this research consists of directing a beam of neutrons from the NBS reactor at crystallized bovine ribonuclease, used as a substitute for the hard-to-get human enzyme counterpart. The neutrons are scattered or reflected at different angles with intensities depending on the type and relative orientation of the atoms they hit. A 1-meter detector linked with a channel analyzer counts the number of neutrons scattered at specific angles. With the help of some sophisticated mathematics, this information is used to draw a map of the crystal's structure.

Working with Sjolin, Wlodawer developed the dynamic mask method to make better use of the data collected about this particular protein. They have subsequently used the procedure to positively establish the orientation of three histidines (a kind of amino acid). These histidines contribute to the enzyme's function as a catalyst in chemically breaking down ribonucleic acid in foods so that the acid's components can be absorbed by the body. By verifying the structure of this enzyme, Wlodawer and Sjolin have confirmed previous theories describing the specific steps of this catalytic process.

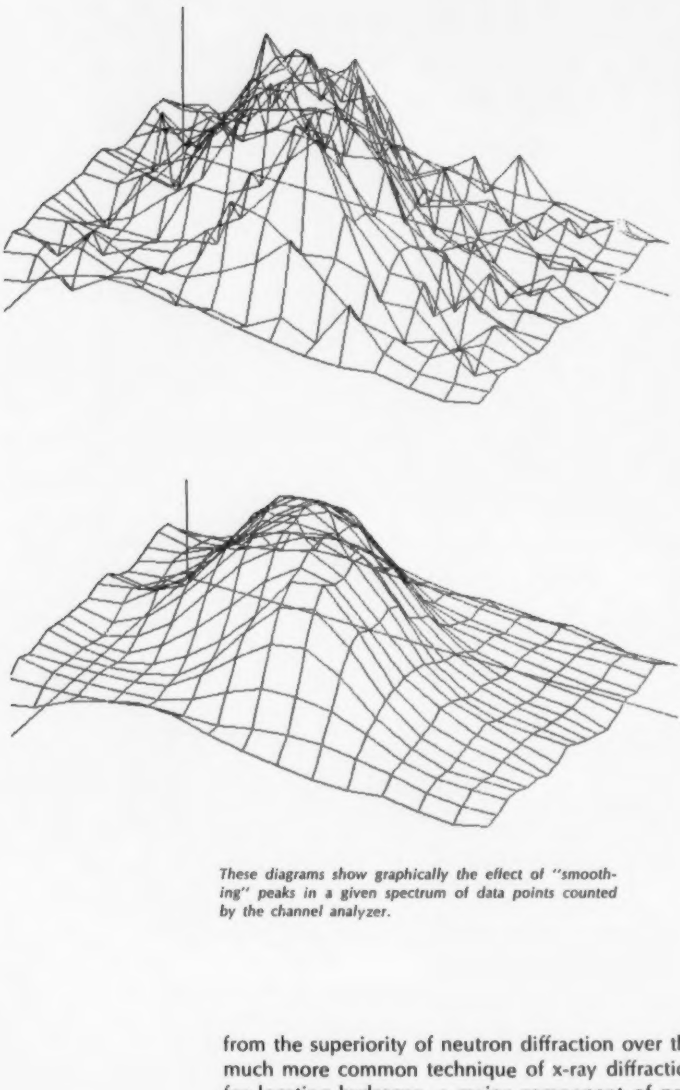
X-rays vs. Neutrons

Their success in describing the crystal stems both from the use of the new statistical technique and





When each mask array is applied to the raw data, peaks that were previously obscured by excess random signals can be uncovered to help describe the crystal under study. Note hidden peaks between channels 320 and 384 and above channel 448.



These diagrams show graphically the effect of "smoothing" peaks in a given spectrum of data points counted by the channel analyzer.

from the superiority of neutron diffraction over the much more common technique of x-ray diffraction for locating hydrogen, a major component of protein molecules. Previous x-ray diffraction studies of ribonuclease have, by necessity, relied on indirect evidence of the hydrogen bonding patterns.

Diffraction techniques involve observing "reflections" of either x-ray or neutron waves that are directed at an angle to the sample under study. The intensity with which atoms in a crystal will scatter x-rays depends on the number of electrons associated with a particular atom. This means diffraction signals from lighter atoms such as hydrogen are usually "swamped" by signals from larger atoms. Neutron diffraction, on the other hand, depends on each atom's neutron cross-section, or its tendency to capture or deflect the path of neutrons. Hydrogen happens to have a very high affinity for neutrons and thus produces a strong signal in neutron diffraction tests.

Signals vs. Background

Normally, says Wlodawer, a crystallographer finds that while there are some neutron reflections that produce prominent peaks in the spectrum of data points counted by the analyzer, there are many other cases where reflection peaks are obscured by excess amounts of random signals. Establishing the intensity of these weaker peaks has therefore been a process of making best "guesstimates."

The dynamic mask procedure alleviates much of this problem by distinguishing between the ordered nature of reflection peaks and the disorder or randomness of background signals. First, a minicomputer uses an algorithm to "smooth" the data generated in a particular test run. In simple terms, this is a kind of "connect the dots" exercise which discards obvious stray points of data. Each point in the smoothed data is then compared to a predetermined curve of known background signals. The farther a particular point varies from the predetermined average background values, the more likely it is that the particular point was produced by a valid reflection and not by random signals.

Each data channel is assigned a value; the number 1 is attached to points likely to be reflection points, and the number 0 is attached to probable background points. The result is an array or mask of values likely to represent reflections amid a sea of 0's or probable background values. After determining the so-called "center of gravity" for a particular array, the computer applies the mask to the unaltered raw data to determine the intensity of each peak and, ultimately, the identity and orientation of individual atoms. In this way, peaks that were previously "buried" by background signals can be uncovered to help describe the crystal under study.

Wlodawer says that the dynamic mask procedure has markedly improved both the quality and the quantity of the neutron diffraction data he is able to collect. He believes the technique would produce similar results for researchers studying complex crystals with x-ray diffraction techniques. G.P. □

ON LINE WITH INDUSTRY

GLASS-LIQUIDUS TEMPERATURE TESTING

by Mario Cellarosi

NBS has recently developed and certified Standard Reference Material (SRM) 773, a soda-lime-silica glass with a liquidus temperature of about 990 °C. Activities leading to the certification for this standard were carried out as part of a cooperative program among industry, Committee C14 of the American Society for Testing and Materials (ASTM), and NBS to develop Standard Reference Materials for glass. NBS had a major role in the research for this activity as well as in leading an ASTM task force of 9 industrial laboratories and NBS in interlaboratory comparisons, procedures, and improvements in methods.

Liquidus temperature is one of the glass properties of particular importance to the industrial production of glass. It is the temperature at which a glass melt becomes unstable with respect to one or more crystalline compounds. In practical terms, however, it is the lowest temperature at which a glass melt can be held for a prolonged time without crystal formation and growth occurring. This property is therefore an important parameter in glass manufacture and must be known to minimize product rejection due to devitrification (crystallization).

Cellarosi is a physicist with the NBS Ceramics, Glass, and Solid State Science Division.

Certified Values for the Gradient-Furnace Liquidus Temperature

Method	Liquidus Temperature
A (boat)	988 ± 3 °C
B (perforated glass)	991 ± 5 °C

In the temperature region just below the liquidus temperature, a glass melt will crystallize rather rapidly. When cooled down further, glass becomes even more thermodynamically unstable, but the increasing viscosity kinetically limits the rate of crystal growth, and glass can be safely held at these temperatures for prolonged periods. An important part of the strategy in glass production, forming, and annealing is, therefore, to remain as briefly as possible in the critical temperature range immediately below the liquidus temperature.

Ideally, the liquidus temperature could be determined through trial and error by holding a large number of samples of a glass at different furnace temperatures. In practice, this is too time-consuming and the use of temperature-gradient furnaces was thus established as ASTM C829-76 standard procedure.

SRM 773 will be used to check glass test methods and to calibrate equipment for liquidus temperature determinations by the gradient furnace methods. These methods are widely used throughout the glass industry. Use of this SRM, in conjunction with standard procedures, will prevent the occurrence of serious measurement discrepancies previously encountered in the glass industry.

The liquidus temperature is particularly important in glass manufacture because it establishes the lowest temperature at which a glass melt can be held without formation of crystals. It therefore sets operating temperatures of glass furnaces and forming and delivery systems. Manufacturing operations very much above liquidus waste energy and degrade furnaces and equipment at a faster rate. Operations below liquidus cause devitrification.

The new SRM will be especially valuable to the glass industry to insure high productivity with a minimum expenditure of energy. It will also aid the industry in research and development of new glasses. This is because devitrification is the chief factor that limits the composition range of technical glasses.

NBS contact for further information concerning this standard reference material is R. K. Kirby, Office of Standard Reference Materials, B316 Chemistry Building, National Bureau of Standards, Washington, DC 20234; 301/921-2536.

Participating Laboratories

- Brockway Glass Co., Brockway, Pa.
- Corning Glass Works, Corning, N.Y.
- Emhart Corp., Hartford, Conn.
- Ford Motor Co., Lincoln Park, Mich.
- Johns-Manville Corp., Denver, Colo.
- Libbey-Owens-Ford Co., Toledo, Ohio
- National Bureau of Standards, Washington, D.C.
- Owens-Corning Fiberglas Corp., Granville, Ohio
- Owens-Illinois, Inc., Toledo, Ohio
- PPG Industries, Creighton, Pa.

Discussing Glass Standards Reference Materials Program at NBS in 1980 are (left to right): Stan Rasberry (Deputy Chief of the NBS Office of Standard Reference Materials), Jane Turner (ASTM Standards Development Division representative), August Siefert (NBS Research Associate), Henry Hagy (Chairman of an ASTM Subcommittee for glass), and Mario Cellarosi (NBS scientist involved in the certification).

STANDARDSTATUS

CHANGES IN SRM INVENTORY

by Stanley D. Rasberry

The greatest new demand for compositional SRM's in the 1980's is expected to be in the area of trace organic analysis of natural matrices. High on our priority list for new trace organic standards are such environmentally important substances as polynuclear aromatic hydrocarbons (PAH). Also high on the list are clinically important biochemical substances such as enzymes, proteins, and therapeutic drugs. However, certification methods of sufficient accuracy must be developed for measuring these substances before SRM's can be produced.

Rasberry is Deputy Chief of the Office of Standard Reference Materials.

Some progress is already being made in developing trace organic SRM's. A human serum matrix SRM certified for trace levels of anticonvulsant drugs, issued in 1979, was the first trace organic reference material produced by NBS in a matrix similar to that of normal test specimens. A series of PAH generator columns and a shale oil have also recently been certified for a number of trace organic constituents. Additionally, NBS has partially completed a human serum matrix SRM certified for important trace organic and inorganic constituents. A large number of new trace organic SRM's will be issued by NBS in the 1980's for applications in clinical chemistry, environmental analysis, and nutrition research.

The new emphasis on trace organic materials does not signal a decline in SRM activity for inorganic compositional analysis. Many SRM's are urgently required and will be provided for trace elemental and bulk compositional analysis. For example, new SRM's are needed for use in quality control of materials for high performance applications such as high temperature and high stress. Considerable demand also exists for SRM's certified for both total concentration of individual elements in naturally occurring matrices and the levels of various inorganic or metallo-organic species in such matrices.

In addition to new SRM's for chemical analysis, a number for new physical properties must also be produced in the 1980's. These include SRM's for accurate measurement of density, voltage, temperature, and optical properties of materials. Of particular importance is the development of SRM's for measuring particle size in the 0.1 to 50 micrometer range and for measuring physical properties of glass. The Office of Standard Reference Materials and the American Society for Testing and Materials are cooperating closely in both of these areas.

Finally, in the area of special engineering properties, an increased emphasis over the decade will be made on new SRM's use in nondestructive evaluation of materials, in evaluation of materials durability and wear, and in standardizing computer instruments and electronics components.

Categories of SRM's and contact persons for each category may be found in the table.

Further information is available from: Office of Standard Reference Materials, B311 Chemistry Building, National Bureau of Standards, Washington, DC 20234.

SRM Types

METALS AND ORES (Robert E. Michaelis)

- Steels
- Steelmaking Alloys
- Cast Irons
- Cast Steels
- Nonferrous Alloys (Alvarez, also)
- Gases in Metals
- High-Purity Metals
- Ores (Seward, also)
- Minerals
- Refractories
- Carbides (Alvarez, also)

ENVIRONMENTAL AND CLINICAL (Robert Alvarez)

- Clinicals (Seward and Kirby, also)
- Biologicals
- Botanicals
- Environmentals (Gills and Seward, also)
- Industrial Hygiene (Kirby and Gills, also)
- Fertilizers
- Trace Elements (Gills, also)

METROLOGY, ENGINEERING, AND PHYSICAL PROPERTIES (R. Keith Kirby)

- Electron Probe Microanalytical
- Glasses
- Cements
- X-ray Diffraction
- Ion Activity
- Mechanical and Metrology
- Superconducting
- Freezing Points
- Melting Points (Seward, also)
- Calorimetric
- Vapor Pressure
- Thermal Conductivity
- Thermal Expansion
- Thermal Resistance
- Thermocouple Materials
- Magnetic
- Optical
- Gas Transmission
- Permittivity
- Resistivity
- Rubber Materials
- Computer Tapes (Seward)
- Sizing Standards
- Color (Seward)
- Photographic (Seward)
- Surface Flammability (Seward)
- Smoke Density (Seward)
- Water Vapor Permeance
- Polymers

RADIOACTIVITY AND ENVIRONMENTAL (Thomas E. Gills)

- Nuclear Materials
- Radioactivity
- Isotopics
- Reference Fuels (Kirby, also)

SPECTROPHOTOMETRY AND PRIMARY CHEMICALS (Richard W. Seward)

- Primary Chemicals
- Metallo-organic Compounds
- Optical-Spectrophotometry

STAFF REPORTS

ANTENNA COUPLING ANALYZED

As antenna systems increase in number and complexity, problems of high-intensity electromagnetic fields around the antennas and of mutual interference between systems become more prevalent. To aid in the prediction of system interference and high-intensity fields, NBS has both developed the theory and translated this theory into two new computer programs for calculating efficiently the mutual coupling between any two antennas arbitrarily oriented and separated in free space, given the far field of each antenna as input.

Arthur D. Yaghjian, Electromagnetic Fields Division, 4085 Radio Building, Boulder, CO 80303; 303/497-5484.

The theory, computer programs, and measurement facilities for efficiently determining the far fields of antennas by measuring the near-field coupling between test and probe antennas have seen extensive development during the past two decades. However, the associated inverse problem of efficiently computing the near-field coupling of two antennas of arbitrary size, orientation, and separation, given the far field of each antenna, has received little attention despite its direct applicability for determining the interference between co-sited antennas, high-intensity fields around antennas, and near-field antenna gain-correction factors.

Two major reasons for this lack of attention have been the difficulty in obtaining the complex vectorial far fields that must be supplied to the computer programs, and the difficulty in developing efficient algorithms for performing the required transformations and integrations. The first difficulty is alleviated for antennas measured using near-field techniques, which yield complex vectorial far fields routinely, or for antennas that conform to analysis by means of physical optics, the geometrical theory of diffraction, or similar asymptotic techniques. The second difficulty dictated the primary objective of the current work: to formulate general expressions and associated computer programs that allow the efficient determination of near-field mutual coupling between two antennas, given the electric far field of each antenna. The computer programs also compute the electric near field of an arbitrary transmitting antenna by inserting a "virtual" receiving antenna with uniform far fields.

In developing the theory, I have placed emphasis on combining efficiency and generality. General expressions for the coupling of antennas have existed for many years in terms of aperture fields, but their numerical evaluation requires an exorbitant amount of computer time for all but electrically small antennas. Moreover, the fast Fourier transform (FFT) evaluation of the plane-wave, antenna coupling expressions, from which much of the theory stems, cannot be applied directly over reasonable distances in the near field of electrically large antennas without encountering prohibitive computer time and storage requirements. Asymptotic techniques (such as the geometrical theory of diffraction) can sometimes be applied to estimate efficiently the mutual coupling between antennas with well-defined edges, feeds, and struts; but such techniques are not developed sufficiently to apply to general antennas.

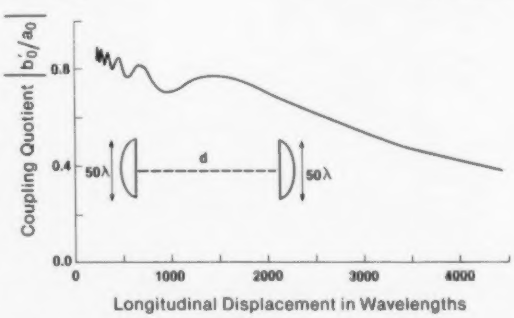


Figure 1—*Coupling as a function of antenna transverse displacement (y).*

The main body of the current work divides conveniently into two major parts. The first part presents the theory and its practical application for computing coupling as a function of relative displacement of two antennas in a transverse plane normal to the axis of separation between them; and the second part determines coupling as a function of displacement of two antennas along the separation axis (i.e., as a function of separation distance). The theory for both sections begins with the Kerns* plane-wave "transmission integral" expressed in terms of the far fields of the two antennas and generalized to allow for the arbitrary orientation of each antenna. However, a different evaluation scheme is required for efficient computation depending on whether coupling values are desired for the antennas displaced transverse to or along the separation axis.

For coupling in the transverse plane, the FFT evaluation is salvaged by collapsing the far-field data and limiting the integration to only the far fields within the sheaf of angles approximately subtended by the two antennas. Limiting the integration to this sheaf of angles artificially bandlimits the coupling quotient in space and thus permits larger integration increments as the separation distance increases—in all reducing computer time to a feasible amount for an arbitrary separation distance.

For the computation of coupling versus separation distance, a new representation for the transmission integral has been

*Kerns, D. M., "Plane-Wave Scattering-Matrix Theory of Antennas and Antenna-Antenna Interactions: Formulation and Applications." Journal of Research of NBS, Vol. 80B, No. 1, Jan-Mar 1976.

formulated. This formulation capitalizes on the interesting result that the coupling quotient, like each rectangular component of electric or magnetic field, satisfies the scalar wave equation and thus can be expanded in a spherical wave series. (This result is analogous to the mutual power spectrum of partial coherence theory.) Because the coefficients in that spherical wave series are directly and conveniently determinable from the scalar product of the electric far fields of the two antennas, the coupling (or fields) along an arbitrary axis spanning the entire Fresnel region can then be computed very rapidly.

For antennas hundreds of wavelengths in diameter, both computer programs take about a minute of computer time within the central memory core of a typical present-day scientific computer. Representative computed coupling curves as functions of transverse and longitudinal displacements of two antennas are shown in figures 1 and 2, respectively.

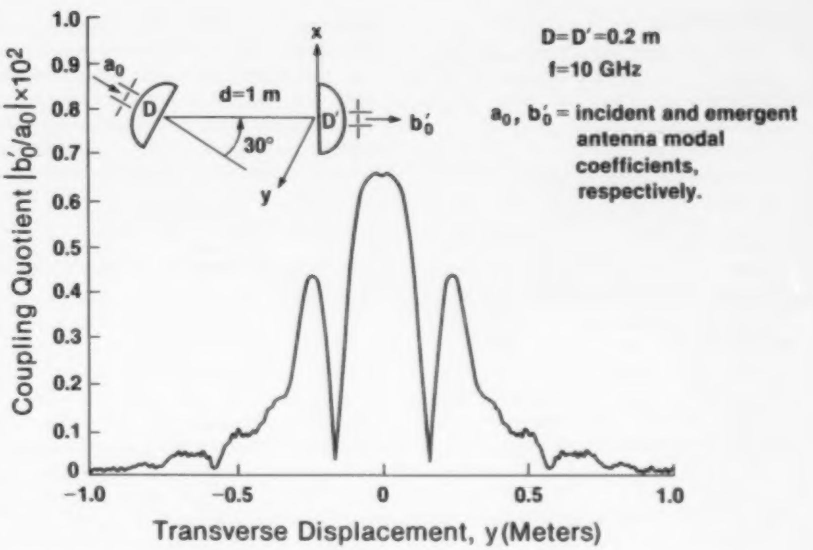


Figure 2—*Coupling as a function of antenna longitudinal displacement (separation distance, d).*

RESEARCH IMPROVES TIME-DOMAIN CALIBRATIONS

Physical modeling and mathematical analysis by NBS scientists in the Electromagnetic Technology Division of the Boulder Laboratories have led to improved measurements of electrical waveforms. Instrument response speed errors and the effects of noise have been reduced, thereby yielding improved waveform measurements in the picosecond to microsecond time domain.

N. S. Nahman and J. R. Andrews, Electromagnetic Technology Division, Room 3550 Radio Building, Boulder, CO, 303/497-3259.

The results of two separate research activities in the Time Domain Metrology group have been applied by J. R. Andrews to improve calibration services for electromagnetic waveform measurements. Typical instruments for which calibrations are affected are impulse generators, tunnel diodes, step generators, and low-pass filters. One effort involved the modeling of a 20-ps (d.c. to 18-GHz) sampling oscilloscope. The sampler modeling was accomplished by N. S. Nahman and S. Riad, a guest worker from the University of Toledo (Ohio). The other effort was the development of a technique to perform stable deconvolution by Nahman and M. Guillaume, a guest worker from the Centre National d'Etudes des Telecommunications (CNET) in Lannion, France. The effects of the measurement instrument, in this case a sampling oscilloscope controlled by minicomputer (the NBS Automatic Pulse Measurement System or APMS), are now routinely removed from time-domain measurements.

Calibrations currently report spectrum amplitude and pulse transition duration, defined as the time required for the pulse amplitude to rise from 10 to 90 percent of its peak value. As a result of the modeling and deconvolution, the customer is now also supplied with the complete deconvoluted waveform. These improved calibration services are performed with no increase in cost to the customer.

The APMS has now also been programmed to perform complete pulse analysis. New parameters include: baseline, topline, amplitude, undershoot, overshoot, leading and trailing edge transition duration (10 to 90 percent and 90 to 10 percent), durations (measured from rise to fall at the 50-percent level), and start and stop times (also measured at the 50-percent level). These are measured for either a single pulse or a complex multiple pulse train. These new parameters will become a part of the calibration service after a thorough error evaluation.

The research efforts that were combined by Andrews to produce the improved calibrations are described in the following.

Deconvolution

Accurate measurement of some natural phenomenon, x(t), is a classical problem (figure 1). Invariably the actual observable output of the measurement process, y(t), is a distorted replica of x(t). This is due to the physical limitations of the measurement instrument, which prevent perfect measurements. If one is dealing with a noise-free linear system, then the measurement instrument can be mathematically described by its pulse response function, h(t). y(t) is given by the convolution of x(t) and h(t),

$$y(t) = x(t) * h(t) \qquad (1)$$

Equation (1) is the symbolic notation for the convolution integral

$$y(t) = \int_0^\infty x(\lambda)\, h(t - \lambda)\, d\lambda. \qquad (2)$$

The problem is then to solve the integral equation (2) for the unknown, x(t). A similar problem that is essentially the same is to determine the transfer properties impulse response, h(t), when the input and output, x(t) and y(t), are known.

One method of deconvolution is to transform the time domain data, x(t) and y(t), to the frequency domain; another method is carried out purely in the time domain. In the Fourier method, the integral relation (2) is transformed into a product relation that provides a simple way to visualize and implement convolution, deconvolution, and filtering or signal processing. The Fourier transforms of x(t), y(t), and h(t) are represented by X(jω), Y(jω), and H(jω), respectively. The convolution integral of equation (2) then reduces to a simple multiplication in the frequency domain. The product form

$$Y(j\omega) = X(j\omega) \cdot H(j\omega) \qquad (3)$$

represents convolution, while the quotient forms

$$X(j\omega) = Y(j\omega)/H(j\omega) \qquad (4)$$

$$H(j\omega) = Y(j\omega)/X(j\omega) \qquad (5)$$

represent deconvolution. In a purely mathematical sense, it is a straightforward problem to solve for either X(jω) or H(jω); x(t) or h(t) can then be obtained from the inverse Fourier transform of equations (4) or (5), respectively.

In a practical sense, with actual measured noise-corrupted data for x(t) and y(t) and a digital computer, it is often difficult to obtain a stable solution from equation (4) or (5). This is due to the inevitable presence of intrinsic physical noise, interference, and errors in the physical data representing x(t) and y(t). The major problems arise when the denominator in equations (4) or (5) becomes quite small and is essentially a noise signal uncorrelated to the numerator, leading to ridiculous, incorrect, rapidly varying, and/or unstable results.

To reduce the effects of errors and noise, an automatic adjustable digital filter, R(jω) (see equation 6), is needed to take into account the noise characteristics of the data and to provide appropriate filtering so that the resultant deconvolution x(t) corresponding to X(jω) is stable and a good approximation to the actual signal, x(t).

$$X(j\omega) = \frac{Y(j\omega)}{H(j\omega)} \cdot |R(j\omega)| \cdot \qquad (6)$$

There are two objectives to be met in the selection of the appropriate digital filter, |R(jω)|. The first is that the mean squared error, e(t), between the estimate of the solution, $\bar{x}(t)$, and the actual signal, x(t), be as small as possible. The second is that the resultant estimate, $\bar{x}(t)$, be relatively "smooth" and not be contaminated with a lot of signal noise enhanced by computational operations. Thus, a mean

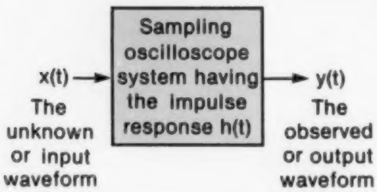


Figure 1—*The input waveform x(t) is not observable; the output waveform y(t) is some distorted replica of x(t).*

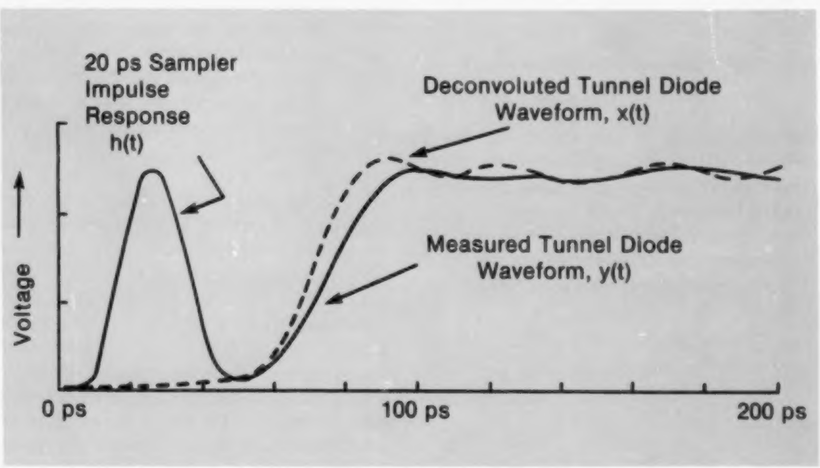


Figure 2—*y(t) is the actual waveform measured by a sampling oscilloscope from a typical tunnel diode pulse generator. h(t) is the sampler's impulse response as determined by computer simulation. x(t) is the estimated, actual output waveform from the pulse generator, based upon deconvolution of h(t) from y(t).*

squared smoothness measure, $s(t)$, is determined for $\tilde{x}(t)$ from the second derivative of $\bar{x}(t)$. The purpose in the selection of the filter R is to minimize $e(t) + \gamma s(t)$, where γ is a relative weighting factor between $e(t)$ and $s(t)$.

One such suitable digital filter, used by Guillaume and Nahman to meet the above criteria, is given by

$$|R(j\omega)| = \frac{|X(j\omega)|^2}{|X(j\omega)|^2 + \gamma|C(j\omega)|^2} \qquad (7)$$

where $C(j\omega)$ is the Fourier transform of the second derivative operator. Complete details of the deconvolution work including the derivation of the filter, computer programs, and examples will be published in 1981.

Modeling

In some situations it is possible to estimate closely a measurement instrument's transfer property impulse response, $h(t)$, by actually observing its response to a very short duration pulse at the input. However, one must know accurately the nature of the impulsive input or test signal. Its duration must be limited to a value much less than that of the true impulse response of the measurement instrument to be characterized.

For a sampling oscilloscope with a 10 to 90 percent transition-duration response of 20 ps, there are no suitable impulsive signal sources available for directly exciting the response, $h(t)$. The shortest-duration available source is the switching transition of a tunnel diode. The fastest of these are comparable to the oscilloscope's speed (i.e., 20 ps). Thus one is left with the "chicken or the egg first?" question, whether to determine accurately from experimental measurements the oscilloscope's impulse response or the tunnel-diode pulse generator's actual output waveform.

One solution to this problem of determining a measurement system's impulse response is to analyze carefully either the measurement instrument or the signal source and develop a mathematical model to predict its behavior. Riad and Nahman, after considerable study, developed a model for an oscilloscope's remote sampling-head that included both the device and network properties of the closed-loop sampling system and the network properties of the signal transmission paths to and from the sampling plane. The model was developed from dimensional and electrical measurements in conjunction with electromagnetic, electronic, and network theory.

The model was used to predict the sampler's step and impulse responses. Computer simulation was performed for the entire model and was done completely in the time domain. It was complicated by the fact the sampling diodes were nonlinear devices. The diodes' equivalent circuit included an exponentially dependent current-vs.-voltage characteristic and a voltage variable capacitance. The work has been documented in NBSIR 78-881.* Recently, refinements have been made to the model and are presently being evaluated.

**Available from NTIS, U.S. Dept. of Commerce, Springfield, VA 22161, Accession No. PB 285206, $13.*

MEASUREMENT PROGRAM FOR STATE WEIGHTS AND MEASURES

The Office of Weights and Measures has completed the first phase of a comprehensive measurement control program in the State weights and measures laboratories. The goal of the program is to provide the State laboratories with a means to verify and document the validity of their day-to-day mass calibrations and to correlate their measurements with those at NBS.

Henry V. Oppermann, NBS Office of Weights and Measures, A363 Physics Building, 301/921-2401

State metrologists are documenting the calibration validity of their State standards by performing repeated intercomparisons over time. The Statistical Engineering Division and the Office of Measurement Services of NBS have helped the Office of Weights and Measures develop a computer program to analyze, plot, and test the data for possible systematic errors. The first results have been reviewed and summarized; control charts prepared from the initial data have been returned to the States for use in monitoring their measurement operations.

NBS is now in the process of analyzing data collected for the second year of the measurement control program. New control charts will combine the new data with the initial data. The control charts will be used by the States in the continuing measurement control program.

Thirty-three of the 53 State laboratories (which include the District of Columbia, Puerto Rico, and the Virgin Islands) have completed the work and received control charts prepared from their initial data. The remaining laboratories are either continuing to collect data or will start to participate in the program as their metrologists receive necessary training and develop their skills.

The original NBS calibrated values for most of the mass standards involved have been confirmed. In a few cases, the results indicate some additional investigation is necessary to determine if a problem exists and recalibration by NBS is necessary.

NBS will calibrate several weight sets. These will be used to investigate any discrepancies in State mass standards from the NBS reported values. The intercomparison of these mass standards with the State standards will specifically indicate which, if any, State standards should be recalibrated. These weight sets will also be used to determine any offset in the measurements made at State laboratories from those made at NBS.

Standards from the weight sets being calibrated by NBS will be distributed to State metrologists for use in performing repeated measurements. These data will then be sent to NBS for analysis and comparison with the NBS reported values as a check on the validity of the control system established for a particular laboratory.

CONFERENCES

For general information on NBS conferences, contact JoAnn Lorden, NBS Public Information Division, Washington, DC 20234, 301/921-2721.

SOFTWARE TECHNOLOGY SYMPOSIUM

The "Trends and Applications 1981: Advances in Software Technology" symposium is to be held at the National Bureau of Standards, Gaithersburg, Maryland, on May 28, 1981.

The event is cosponsored by the NBS Institute for Computer Sciences and Technology, the Washington, D.C. chapter of the Institute of Electrical and Electronics Engineers (IEEE) Computer Society, and the IEEE Washington section.

In particular, the program will feature papers of a tutorial nature and those presenting new research in such areas as:

- software engineering
- software quality control
- distributed processing
- computer communications
- database software
- programming and operating systems
- secure software
- performance evaluation
- novel applications

Committee officials are I. Gray Kinnie, Conference Chairperson, IBM, 703/841-7329, and Elizabeth G. Parker, NBS Liaison.

For further information contact: Elizabeth G. Parker, A209 Administration Building, 301/921-2834.

CONFERENCE CALENDAR

March 2-4
MEASUREMENT OF ELECTRICAL QUANTITIES IN PULSE POWER SYSTEMS, NBS, Boulder, CO; sponsored by NBS; contact: Ronald McKnight, B344 Metrology Building, 301/921-3121.

***March 9-12**
5TH INTERNATIONAL CONFERENCE ON SOFTWARE ENGINEERING, San Diego, CA; sponsored by NBS, ACM, and IEEE; contact: S. Jeffery, A247 Technology Building, 301/921-3531.

March 17-18
SECOND CONFERENCE ON CONSUMER PRODUCT STANDARDS, NBS, Gaithersburg, MD; sponsored by NBS and ASTM; contact; Walter Leight, 111 EM Building, 301/921-3750.

***March 20-21**
MAKING INVENTION WORK, Bloomington, MN; sponsored by NBS, DOE, and AAES; contact: G. Lewett, A46 Technology Building, 301/921-3694.

April 6-10
6TH INTERNATIONAL SYMPOSIUM ON NOISE IN PHYSICAL SYSTEMS, NBS, Gaithersburg, MD; sponsored by NBS and the Catholic University of America; contact: Robert J. Soulen, B128 Physics Building, 301/921-2018.

***April 14-15**
NATIONAL WATER CONSERVATION CONFERENCE, Denver, CO; sponsored by NBS, EPA, DOI, COE, HUD, and WRC; contact: L. Galowin, B306 Building Research, 301/921-3293.

April 21-24
MECHANICAL FAILURES PREVENTION GROUP, NBS, Gaithersburg, MD; sponsored by NBS and MFPG; contact: H. Burnett, B266 Materials Building, 301/921-2992.

April 30-May 1
NATIONAL ROOFING TECHNOLOGY CONFERENCE, NBS, Gaithersburg, MD; sponsored by NBS and NRCA; contact: Robert Mathey, B348 Building Research, 301/921-2629.

***May 28**
TRENDS AND APPLICATIONS, NBS, Gaithersburg, MD; sponsored by NBS and IEEE; contact: Elizabeth Parker, A209 Administration Building, 301/921-2834.

June 1-3
6TH INTERNATIONAL SYMPOSIUM ON IMAGING AND ULTRASONIC TISSUE CHARACTERISTICS, NBS, Gaithersburg, MD; sponsored by NBS, NIH, IEEE, and AIUM; contact: Melvin Linzer, A366 Materials Building, 301/921-2611.

***June 3**
ASTM G-2 SYMPOSIUM ON FRETTING WEAR, NBS, Gaithersburg, MD; sponsored by NBS and ASTM; contact: Arthur W. Ruff, B114 Materials Building, 301/921-2966.

June 8-12
SECOND INTERNATIONAL CONFERENCE ON PRECISION MEASUREMENTS AND FUNDAMENTAL CONSTANTS, NBS, Gaithersburg, MD; sponsored by NBS, IUPAP, and AMCO; contact: Barry N. Taylor, B258 Metrology Building, 301/921-2701.

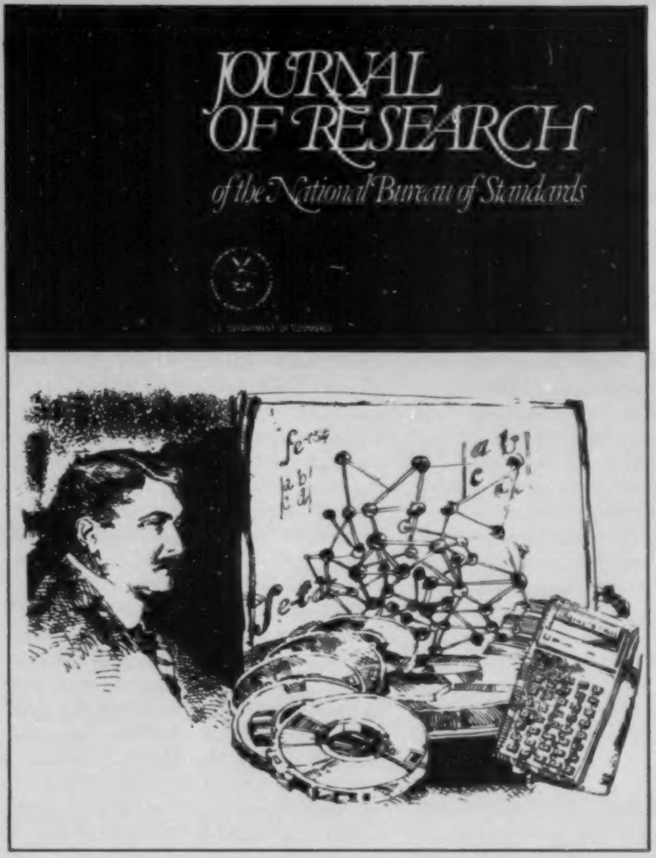
June 15-19
INTERNATIONAL JOINT CONFERENCE ON THERMOPHYSICAL PROPERTIES, NBS, Gaithersburg, MD; sponsored by NBS, ASME, and Purdue University; contact: A. Cezairliyan, Room 124 Hazards Building, 301/921-3687.

June 18
20TH ANNUAL ACM SYMPOSIUM, UNIVERSITY OF Maryland, College Park, MD; sponsored by NBS and ACM; contact: Wilma Osborne, A265 Technology Building, 301/921-3485.

August 10-14
CRYOGENICS—AN ESSENTIAL FOUNDATION FOR ADVANCED TECHNOLOGY, San Diego, CA; sponsored by NBS, and Cryogenic Engineering Conference; contact: Dee Belsher, Program Information Office, Room 4001-Building 1, Boulder, CO 80303, 303/497-3981.

September 14-16
SECOND INTERNATIONAL CONFERENCE ON THE DURABILITY OF BUILDING MATERIALS AND COMPONENTS, NBS, Gaithersburg, MD; sponsored by NBS, ASTM, NRC of Canada, International Council for Building Research Studies and Documentation, International Union of Testing and Research Laboratories for Materials and Structures; contact: Geoffrey Frohnsdorff, B348 Technology Building, 301/921-3485.

**New Listings*



Subscribe now—The new National Bureau of Standards Journal

The expanded Journal of Research of the National Bureau of Standards reports NBS research and development in those disciplines of the physical and engineering sciences in which the Bureau is active. These include physics, chemistry, engineering, mathematics, and computer sciences. Papers cover a broad range of subjects, with major emphasis on measurement methodology, and the basic technology underlying standardization. Also included from time to time are survey articles on topics closely related to the Bureau's technical and scientific programs. As a special service to subscribers each issue contains complete citations to all recent NBS publications in NBS and non-NBS media. Issued six times a year. Annual subscriptions: domestic $13.; foreign $16.25. Single copy, $3. domestic; $3.75 foreign.

- Note: The Journal was formerly published in two sections: Section A "Physics and Chemistry" and Section B "Mathematical Sciences."

NBS Board of Editors
Churchill Eisenhart, Executive Editor (Mathematics)
John W. Cooper (Physics)
Donald D. Wagman (Chemistry)
Andrew J. Fowell (Engineering)
Joseph O. Harrison (Computer Science)
Howard J. M. Hanley (Boulder Labs.)

Subscription Order Form
Enter my subscription to NBS Journal of Research at $13. Add $3.25 for foreign mailing. No additional postage is required for mailing within the United States or its possessions. (SJRA—File Code 2N)

Send Subscription to:

Name-First, Last

Company Name or Additional Address Line

Street Address

City | State | Zip Code

(or) COUNTRY

PLEASE PRINT

Credit Card Orders Only
Total charges $ ______ . Fill in the boxes below.
Credit Card No.
☐ VISA ☐ MasterCard
Expiration Date Month/Year

☐ Remittance Enclosed. Domestic: Check or money order. Foreign: International money order, draft on an American or Canadian Bank, or by UNESCO coupons. Made payable to the Superintendent of Documents.

☐ Charge to my Deposit Account No.

MAIL ORDER FORM TO:
Superintendent of Documents
Government Printing Office
Washington, D.C. 20402

PUBLICATIONS

DATA ENCRYPTION STANDARD

*Gait, J., Maintenance Testing for the Data Encryption Standard, Nat. Bur. Stand. (U.S.), Spec. Publ. 500-61, 28 pages (Aug. 1980) Stock No. 003-003-02225-0, $2.**

Four readily applied maintenance tests for the Federal information processing Data Encryption Standard (DES) are described in a new National Bureau of Standards publication.

The 29-page publication, *Maintenance Testing for the Data Encryption Standard* (SP 500-61), describes the tests as independent of implementation and fast enough to test DES devices during actual operation. Only a partial test may be needed in a particular application but the four maintenance tests are so designed that a full functional test can be executed if it is convenient and desirable to do so. The tests, using a small program and minimum data, are defined as stopping points in a general testing process and satisfy four requirements depending on the thoroughness of testing desired.

Serving as the standard cryptographic algorithm used by the Federal Government to protect non-classified transmission and storage of computer data, the DES is normally implemented in hardware. DES devices are presently available in the marketplace.

RETROFIT INSULATION PERFORMANCE

Weidt, J. L., Saxler, R. J., and Rossiter, W. J., Jr., Field Investigation of the Performance of Residential Retrofit Insulation, Nat. Bur. Stand. (U.S.), Tech. Note 1131, 67 pages (Sept. 1980) Stock No. 003-003-02243-8, $3.75.

*Publications cited here may be purchased at the listed price from the U.S. Government Printing Office, Washington, DC 20402 (foreign: add 25 percent). Microfiche copies are available from the National Technical Information Service, Springfield, VA 22161. For more complete periodic listings of all scientific papers and articles produced by NBS staff, write: Editor, Publications Newsletter, Administration Building, National Bureau of Standards, Washington, DC 20234.

This report summarizes the results of an NBS study conducted to obtain information on the performance of in-service insulations of the type commonly used in the United States to retrofit side-walls of housing: urea-formaldehyde based foam, loose-fill cellulose, and loose-fill mineral fiber.

In the field phase of the study, observations were made on performance-related factors such as: the completeness of filling the cavity, the condition of the insulation and wall components, and evidence of moisture accumulation such as water stains on sheathing, studs, and other wall components. Shrinkage was observed to have occurred for all urea-formaldehyde based foam specimens. Where measurable, it was found to be within a range of 4 to 9 percent. For the six test houses containing loose-fill insulation, which were open at the top of the wall cavity, only one with cellulose contained a void of undetermined origin at the location.

Insulation specimens removed from the walls were tested to determine their density, thermal resistivity, and moisture content. The pH and moisture absorption of the urea-formaldehyde based foam specimens were also determined. Results of the laboratory measurements are discussed and compared with data from other studies. Relationships between the moisture contents of the samples and their thermal resistivities were not found. Results indicated that the retrofitting of the inspected sidewalls was for the most part accomplished without adverse effect upon them.

This study was coordinated by the NBS Center for Building Technology under sponsorship of the Department of Energy's Office of Weatherization Assistance. The report was prepared by John L. Weidt and Robert J. Saxler of John Weidt Associates, Inc. and Walter J. Rossiter, Jr., of NBS.

TIME-SAVING SYSTEM FOR INDEXING

Kaetzel, L. J., Glass, R. A., and Smith, G. R., A Computer Data Base System for Indexing Research Papers, Nat. Bur. Stand. (U.S.), Tech. Note 1123, 90 pages (Oct. 1980) Stock No. 003-003-02245-4, $4.25.

Researchers at the National Bureau of Standards have developed an easy-to-use computerized system for indexing, classifying, retrieving, and editing citations of research papers. The system should help researchers reduce administrative and clerical tasks while improving the usefulness of filed research papers.

Developed by Lawrence J. Kaetzel, Robert A. Glass, and George R. Smith of the NBS Center for Building Technology, the "KGS" system reduces the time spent by the researcher in identifying the physical storage locations (e.g., file drawer) of research papers through the file code. A major advantage of implementing a system for personal copies of research papers is that it allows the user to consider all copies of papers in the researcher's possession as forming a broad research data base that can be easily accessed. In this way a given collection of papers can be used with greater efficiency to help support a variety of different research projects dealing with similar topics.

The "KGS" data base system is written in FORTRAN V Level 1 programming language and may be implemented with most minicomputer systems and by some microcomputers with sufficient disk and memory capacity. The system can be set up and accessed on a computer terminal in a research laboratory or office.

COMPUTER PERFORMANCE GROUP'S 16TH MEETING

Highland, H. J., Computer Performance Evaluation Users Group (CPEUG), Nat. Bur. Stand. (U.S.), Spec. Publ. 500-65, 316 pages (Oct. 1980) Stock No. 003-003-02250-1, $8.

More than 30 forward-looking papers are included in the proceedings of the 16th meeting (Orlando, Fla., Oct. 20-23,

1980) of the *Computer Performance Evaluation Users Group (CPEUG),* now appearing as a new publication of the National Bureau of Standards.

The papers, addressing the conference theme, "CPE (Computer Performance Evaluation) Trends in the 80's," deal with new applications and with changes that may occur in traditional areas during the decade ahead. Sponsored by the NBS Institute for Computer Sciences and Technology, the conference was hosted by the Navy Data Automation Facility, Naval Training Center, Orlando. Divided into two parallel sessions, the program included technical papers on previously unpublished work, case studies, tutorials, and panels. Technical papers are presented in the proceedings in their entirety.

POLICE PHOTOGRAPHIC EQUIPMENT

Grover, C. C., Selection and Application Guide to Police Photographic Equipment, Nat. Bur. Stand. (U.S.), Spec. Publ. 480-23, 65 pages (1980) Stock No. 003-003-02224-1, $3.75.

A new handbook for the law enforcement community, *Selection and Application Guide to Police Photographic Equipment,* has just been issued by the National Bureau of Standards.

The 65-page guide is designed to help enforcement and procurement officials who are not technically trained in photography choose and operate equipment relevant to their needs.

"Law enforcement photography," the introduction states, "probably encompasses a broader range of specialized photographic skills than any other recognized branch of the photographic profession." Nearly every sector of the law enforcement field makes extensive daily use of photography—as documentation, evidence, training, aids, or material for public education.

This pamphlet outlines typical photographic assignments—such as crime scene, physical evidence, identification, and surveillance—and the corresponding types of photos required. Special problems and useful techniques to solve them are described: cameras, lenses, film, exposure meters, lighting equipment, and accessories are outlined in detail. Amply illustrated, the guide emphasizes applications to law enforcement.

Prepared by the Naval Surface Weapons Center, the manual was coordinated by the Bureau's Law Enforcement Standards Laboratory under the sponsorship of the National Institute of Law Enforcement and Criminal Justice.

PUBLICATIONS LISTING

Atomic and Molecular Studies

Zalubas, R., and Albright, A., Bibliography on Atomic Energy Levels and Spectra July 1975 through June 1979, Nat. Bur. Stand. (U.S.), Spec. Publ. 363, Suppl. 2, 119 pages (Oct. 1980) Stock No. 003-003-02267-5, $4.50.

Building Technology

Ellingwood, B. R., Ed., An Investigation of the Miyagi-Ken-Oki, Japan, Earthquake of June 12, 1978, Nat. Bur. Stand. (U.S.), Spec. Publ. 592, 232 pages (Oct. 1980) Stock No. 003-003-02257-8, $6.50.

Milton, H. J., and Berry, S. A., Metric Conversion in the Construction Industries—Technical Issues and Status, Nat. Bur. Stand. (U.S.), Spec. Publ. 598, 145 pages (Oct. 1980) Stock No. 003-003-02265-4, $5.

Computer Science and Technology

Highland, H. J., Ed., Computer Science and Technology: Computer Performance Evaluation Users Group (CPEUG). Proceedings of the Sixteenth Meeting held at Orlando, FL, Oct. 20-23, 1980, Nat. Bur. Stand. (U.S.), Spec. Publ. 500-65, 316 pages (Oct. 1980) Stock No. 003-003-02250-1, $8.

Hilsenrath, J., Summary of On-Line or Interactive Physico-Chemical Numerical Data Systems, Nat. Bur. Stand. (U.S.), Tech. Note 1122, 24 pages (Oct. 1980) Stock No. 003-003-02259-4, $1.75.

Levitt, K. N., Neumann, P., and Robinson, L., Computer Science and Technology: The SRI Hierarchial Development Methodology (HDM) and its Application to the Development of Secure Software, Nat. Bur. Stand. (U.S.), Spec. Publ. 500-67, 54 pages (Oct. 1980) Stock No. 003-003-02258-6, $3.75.

Mink, A., Computer Science and Technology: An Analytic Study of a Shared Device Among Independent Computing Systems, Nat. Bur. Stand. (U.S.), Spec. Publ. 500-69, 176 pages (Nov. 1980) Stock No. 003-003-02227-3, $5.50.

Energy Conservation and Production

Mathey, R. G., and Rossiter, W. J., Jr., Guidelines for the Installation of Solar Components on Low-Sloped Roofs, Nat. Bur. Stand. (U.S.), Tech. Note 1134, 81 pages (Nov. 1980) Stock No. 003-003-02261-6, $4.

Engineering, Product, and Information Standards

Milton, H. J., International and National Standards on Dimensional Coordination, Modular Coordination, Tolerances and Joints in Buildings, Nat. Bur. Stand. (U.S.), Spec. Publ. 595, 154 pages (Oct. 1980) Stock No. 003-003-02254-3, $5.50.

Measurement Science and Technology Policy and State-of-the-Art Surveys

Gurewitz, P. H., Hydraulic Research in the United States and Canada, 1978, Nat. Bur. Stand. (U.S.), Spec. Publ. 583, 397 pages (Oct. 1980) Stock No. 003-003-02247-1, $8.50.

Standard Reference Data

Janz, G. J., Molten Salts Data as Reference Standards for Density, Surface Tension, Viscosity, and Electrical Conductance: KNO_3 and NaCl, J. Phys. Chem. Ref. Data 9, No. 4, 791-830 (1980).

Janz, G. J., and Tomkins, R. P. T., Molten Salts: Volume 5, Part 1—Additional Single and Multi-Component Salt Systems. Electrical Conductance, Density, Viscosity, and Surface Tension Data, J. Phys. Chem. Ref. Data 9, No. 4, 831-1022 (1980).

Hubbell, J. H., Gimm, H. A., and Overbo, I., Pair, Triplet, and Total Atomic Cross Sections (and Mass Attenuation Coefficients) for 1 MeV-100 GeV Photons in Elements $Z = 1$ to 100, J. Phys. Chem. Ref. Data 9, No. 4, 1023-1148 (1980).

Shimanouchi, T., Matsuura, H., Ogawa, Y., and Harada, I., Tables of Molecular Vibrational Frequencies —Part 10, J. Phys. Chem. Ref. Data 9, No. 4, 1149-1254 (1980).

Watson, J. T. R., Basu, R. S., and Sengers, J. V., An Improved Representative Equation for the Dynamic Viscosity of Water Substance, J. Phys. Chem. Ref. Data 9, No. 4, 1255-1290 (1980).

Uematsu, M., and Franck, E. U., Static Dielectric Constant of Water and Steam, J. Phys. Chem. Ref. Data 9, No. 4, 1291-1306 (1980).

Marcus, Y., Compilation and Evaluation of Solubility Data in the Mercury (I) Chloride-Water System, J. Phys. Chem. Ref. Data 9, No. 4, 1307-1330 (1980).

NEWS BRIEFS

MOON PUT TO USE IN MEASURING ANTENNA EFFICIENCY. NBS researchers are helping the U.S. Army to use the moon as a source of microwave energy for calibrating certain satellite communications antennas. The more efficiently the antennas work, the more channels of communication that can be used and the better the quality of the transmission. The moon, as it happens, emits reasonably homogeneous amounts of electromagnetic radiation. Thus, by pointing the antennas directly at the moon and taking certain measurements, small ground-based antennas can be calibrated.

SPEED-MEASURING RADAR DEVICES: DRAFT PERFORMANCE STANDARDS. An NBS-drafted performance standard for speed-measuring radar devices has been formally proposed by the Department of Transportation's National Highway Traffic Safety Administration (NHTSA). The proposed performance requirements and test methods for evaluating radar devices used by law enforcement agencies were requested by NHTSA in 1977 after the national 55-mph speed limit was set. After public comment, the final NHTSA standard will be used to establish a qualified products list. Only those devices that meet the standard will be placed on the list for purchase by State and local Governments with Federal highway funds. There are currently no such standards regulating the quality of radar devices.

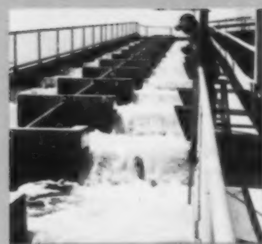
REACTIVE GAS GENERATOR. NBS researchers Wing Tsang and James A. Walker with professor Douglas W. Cornell of Fairleigh Dickinson University have been awarded a patent for a device that can generate controlled amounts of highly reactive gases at very low concentrations. The device is designed to produce calibration samples for adjusting instruments used in toxicology and pollution research, where gas concentration measurements are routinely made at the part per million level and lower. The device works by decomposing dilute solutions of less reactive parent compounds through heating. A few of the many gases that can be generated in this manner are formaldehyde, hydrogen cyanide, sulphur dioxide, and acrolein.

NBS PIONEER ATOMIC CLOCK TO SMITHSONIAN. The world's first atomic clock, built by NBS in 1949, has been loaned to the Smithsonian Institution in Washington, DC, for inclusion in an upcoming (late 1981) exhibit on atomic clocks. The device used microwave absorption in ammonia as its standard of frequency to achieve an accuracy of about one part in 10 million. The present NBS primary time and frequency standard is about a million times more accurate.

AID TO COMPUTER NETWORK USERS. End users of computer network services often find that even the same services may have different access procedures when offered on different systems. The NBS Network Access Machine (NAM) is an implementation of one approach to the access problem. A new publication now describes The Expert Assistance System for the NBS Network Access Machine (SP 500-68), available for $2.50 from the Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402. Order by Stock No. 003-003-02275-6.

NEXT MONTH IN

DIMENSIONS NBS



Fish ladders on dams in the Pacific Northwest play a critical part in salmon statistics and hence in the salmon fishing industry. You might well ask what the National Bureau of Standards has to do with the salmon fishing industry. March DIMENSIONS/NBS provides an answer.

U.S. DEPARTMENT OF COMMERCE
Malcolm Baldrige, Secretary

NATIONAL BUREAU OF STANDARDS
Ernest Ambler, Director

Prepared by the Public Information Division
Washington, DC 20234

Richard S. Franzen, Chief

Sharon Shaffer, Chief
General Publications

Marian S. Cord, Editor

Justine A. Williams, Assistant Editor

Stan Lichtenstein, Production

Walt Mortensen, Visual Editor
(Commerce Department)

PHOTO CREDITS

Photo on page 2 Courtesy of Department of Energy, by Jack Schneider.
Mark Helfer page 6 (left), 9, 12, 14, and 18.
Cover 3 Courtesy of NOAA, NMFS, Scientific Publications Staff.

The Commerce Department's National Bureau of Standards was established by Congress in 1901 to advance the Nation's science and technology and to promote their application for public benefit. NBS research projects and technical services are carried out by the National Measurement Laboratory, the National Engineering Laboratory, and the Institute for Computer Sciences and Technology. Manufacturing, commerce, science, government, and education are principal beneficiaries of NBS work in the fields of scientific research, test method development, and standards writing. DIMENSIONS/NBS describes the work of NBS and related issues and activities in areas of national concern such as energy conservation, fire safety, computer applications, materials utilization, and computer product safety and performance. The views expressed by authors do not necessarily reflect policy of the National Bureau of Standards or the Department of Commerce.

For sale by the Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402. Annual subscription: Domestic $11.00, foreign, $13.75. Single copy: Domestic, $2.25, foreign, $2.85. The Secretary of Commerce has determined that the publication of this periodical is necessary in the transaction of the public business required by law of this Department. Use of funds for printing this periodical has been approved by the Director of the Office of Management and Budget through June 30, 1981.

AN EQUAL OPPORTUNITY EMPLOYER

U.S. DEPARTMENT OF COMMERCE
National Bureau of Standards
Washington, DC 20234

OFFICIAL BUSINESS
Penalty for Private Use, $300
RETURN POSTAGE GUARANTEED

POSTAGE AND FEES PAID
U.S. DEPARTMENT OF COMMERCE
COM-215

U.S.MAIL

CONTROLLED CIRCULATION RATE